Design Engineering

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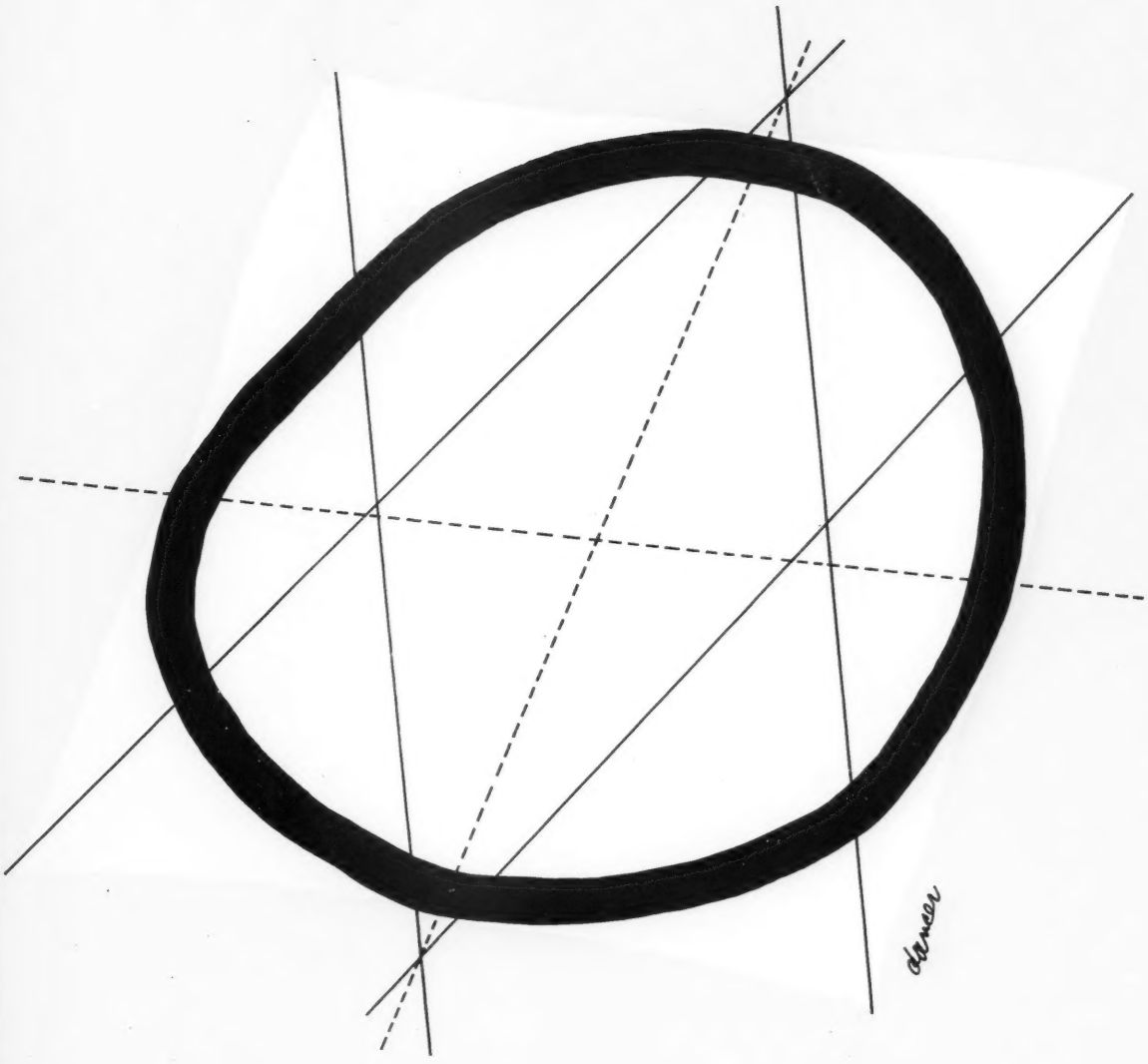

APPROXIMATING CURVES BY USING CIRCULAR ARCS (page 50)

Canada's ball and roller bearing industry

Milling done by chemistry

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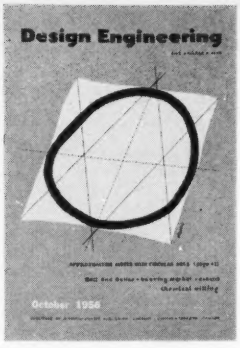

Design Engineering

VOL. 2 **OCTOBER 1956** NO. 10

This month's cover

If you'd had to step into artist Don Dancer's shoes in September and think up a cover design for this month's issue what would you have come up with? Remember now, your resulting cover has to relate to the feature article on the aproximation of curves by circular arcs. Tough problem? We think that Don (who probably has trouble adding a two-item grocery bill) came up with a snappy combination of art, mathematics and lime rickey.

Design Engineering

MEMBER

CCAB

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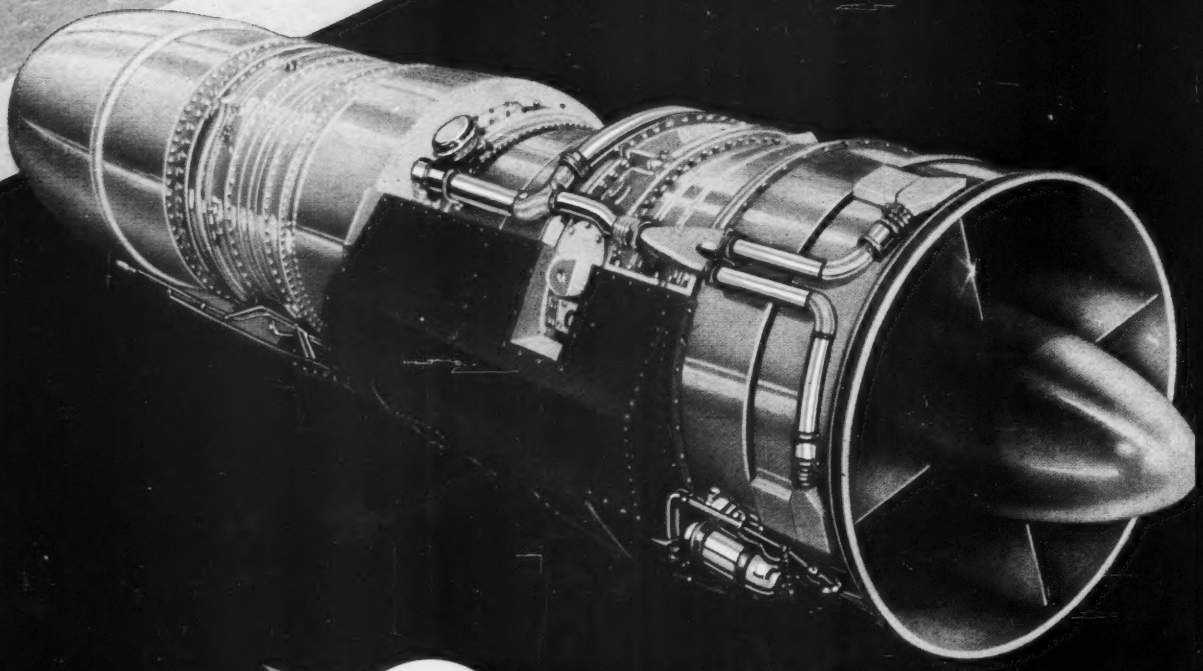
IROQUOIS,

Orenda's supersonic turbojet,

has passed its fifty hour flight rating test—

successfully, and on schedule.



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The November issue of **Design Engineering** will carry strong feature articles written by contributors no less experienced than those featured this month.

As packed as usual with interesting articles, the big drum in the November issue will be beaten by an article on cold extrusions. On hand with some of the other drumsticks will be articles on valves for skin diving equipment, diesel cars, pillofoam, hydraulic packings, speed variators and snow blowers. We are also hoping to give a report of the Canadian I.R.E. Show.

Sheppard

Author of this issue's article on approximating curves by circular arcs is **W. H. Sheppard** of Avro Aircraft who has spent most of his career working in the aircraft industry. He attended Woolwich Polytechnic and graduated in Electrical and Mechanical Engineering from King's College, London in 1937. Since then he has worked for the British Air Ministry and for the Bristol Aeroplane Co. His hobbies consist of "writing technical articles on the basis of my own investigations," touring Europe on foot and bicycle and recently and appropriately—flying lessons.

Whiting

J. F. Whiting is no stranger to Design Engineering, having been in print in these pages before. He is a writer of technical handbooks in the publications division of Aluminum Laboratories, Kingston, and the high speed welding of aluminum is the subject of his article in this issue. A graduate of Queen's University in 1941, he worked for seven years on the technical staff of the company dealing with the problems of heat treatment. Active in church work, Whiting takes his relaxation in the form of woodworking and an active interest in sports.

Macdonald

John L. Macdonald, who wrote the neoprene article for us, is product manager—elastomers, in the Chemicals Department of Du Pont of Canada in Montreal. He received his early education in schools in Oregon, Washington and British Columbia and obtained his B.A. from U.B.C. in Vancouver. He joined what is now Du Pont of Canada in 1943 and later became sales representative for general chemicals in Winnipeg. In 1947 he transferred to Montreal and in 1953 became product manager for pigments and rubber chemicals. His latest appointment came this year.

Michael

T. H. Glynn Michael wrote the protective coating article for the October issue. Michael, who is Director of Research, Howards and Sons (Canada) Ltd., graduated from the University of Toronto (honor chemist) and has had experience with the Protective Coatings Laboratory of the National Research Council and with Woburn Chemicals in Toronto where he was Chief Engineer before joining Howards. His interests outside his work centre around his three children, suburban living and determined efforts to reduce his golfing handicap.

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Reports

News in brief from the world's producers

Electricity from Gases

The fuel cell, a battery that produces electricity from such gases as hydrogen and oxygen, is one of the many new devices under study at the new Parma, Ohio, basic research laboratories of National Carbon Company.

When ultimately developed, commercial fuel cells may be used for reserve or standby power supplies, according to Dr. Robert G. Breckenridge, director of the new laboratories.

"In ordinary batteries," Dr. Breckenridge points out, "energy is obtained from metals and other substances in the form of charged particles. The flow of these particles is the electric current for flashlights, hearing aids, portable radios and so on. Recent research indicates the new possibility of making a battery which will obtain its energy, its supply of charged particles, entirely from gases such as oxygen and hydrogen."

• • •

Antarctic Crews Gather

Hunting aircrew from operations in many far-flung parts of the world including the North Pole, are gathering at Oshawa Airport near Toronto in preparation for the British Government's second air survey of the Antarctic. The two Canso amphibious aircraft which did part of the 60,000 square mile survey last year are being readied for their arduous duties by Field Aviation Company Limited, Hunting's servicing and overhaul organization.

• • •

C-A-T- spells Cat

In an effort to raise the standard of spelling ability of high school graduates before entering business, the National Office Management Association will shortly launch its third annual spelling project in Canada and the United States.

This year, if progress continues, several hundred thousand students may be expected to participate in studying a list of 900 key words to be distributed by NOMA Chapters to high schools and taking the three tests of 100 words each.

Awards to successful students passing the tests are embossed certificates presented at student-faculty assemblies. Last year, 500 students earned the Association's "Spelling Proficiency Certificates." An additional 1,200 received "Spelling Progress Certificates" for passing two of the tests. Those students who passed only one test received "Spelling Certificates." The project is entirely cost free to student and school.

• • •

New Firm in Canada

Associated British Engineering Limited recently announced the formation of a wholly owned subsidiary company, Associated British Engineering (Canada) Ltd., with head office in Montreal.

The Canadian subsidiary has in turn acquired the Hepworth Lachine Engineering Co. of Montreal.

The parent British company manufactures a wide range of marine and industrial diesel engines and allied equipment.

• • •

Women Engineers

Technical training of women as a solution for the serious shortage of engineers in Canada was recently suggested by J. L. McMurray, RCA Victor Company, Ltd. He claims that more women could and should be induced to enter the engineering profession.

Himself an engineer and vice-president, McMurray forecasts that the skill of women engineers and scientists will be increasingly required in Canada.

"While this company is not suffering at the moment from the general shortage of engineers and scientists, we know that there will be a shortage soon. With new electronic devices now being developed, our engineering products department alone anticipates needing double its staff by 1960," he said.

RCA Victor, which employs highly trained women in several key posts, finds them quite as good as men, said McMurray.

"A woman unquestionably has as much grey matter as a man. Female architects and airplane designers are quite as good as their male colleagues. And for tedious and repetitious tasks, women work out better than men. They've more patience," declared the executive.

• • •

"Shall We Dance?"

Guy Lombardo's internationally famous dance orchestra has been engaged during October by the Association of Professional Engineers of the Province of Ontario. To enable the maximum number of members to participate, as well as to ensure satisfactory financing, dances will be held in the Royal York Hotel, Toronto, and the Chateau Laurier, Ottawa. These provide the only ballroom facilities adequate for the numbers.

The dance at the Royal York Hotel, Toronto, will be on the evening of Monday, October 29th. On the succeeding evening Tuesday, October 30th, Lombardo's orchestra will provide dance music for Association members at the Chateau Laurier, in Ottawa. Guy Lombardo and his famous band are well known to dance, radio and television fans of this continent.

Remember the dates—Toronto, Royal York Hotel, October 29; Ottawa, Chateau Laurier, October 30, 1956!

• • •

Flying Safety

Some 200 top design engineers of Avro Canada Ltd. met with Brigadier-General J. D. Caldara of the U. S. Air Force in August to discuss safety in today's air craft industry.

Headquarters director of the U. S. Air Force flight safety division, Gen. Caldara is considered one of the top aircraft safety experts in the U. S. He came to discuss accident prevention programs with Canadian aircraft personnel at the invitation of Avro.

The wide-scale use of fast jet aircraft today, with the increased dependence on delicately adjusted control instruments, makes a safety program from the aircraft design stage to pilot training and supervision an absolute must, Gen. Caldara stated.

"There could be a saving of $600,000 a day in the U. S. in aircraft investment if the maintenance and supervisory errors that cause some two thirds of all accidents today could be overcome."

A team of safety experts headed by General Caldara has carried out safety programmes at all the major aircraft manufacturing firms in the U. S.

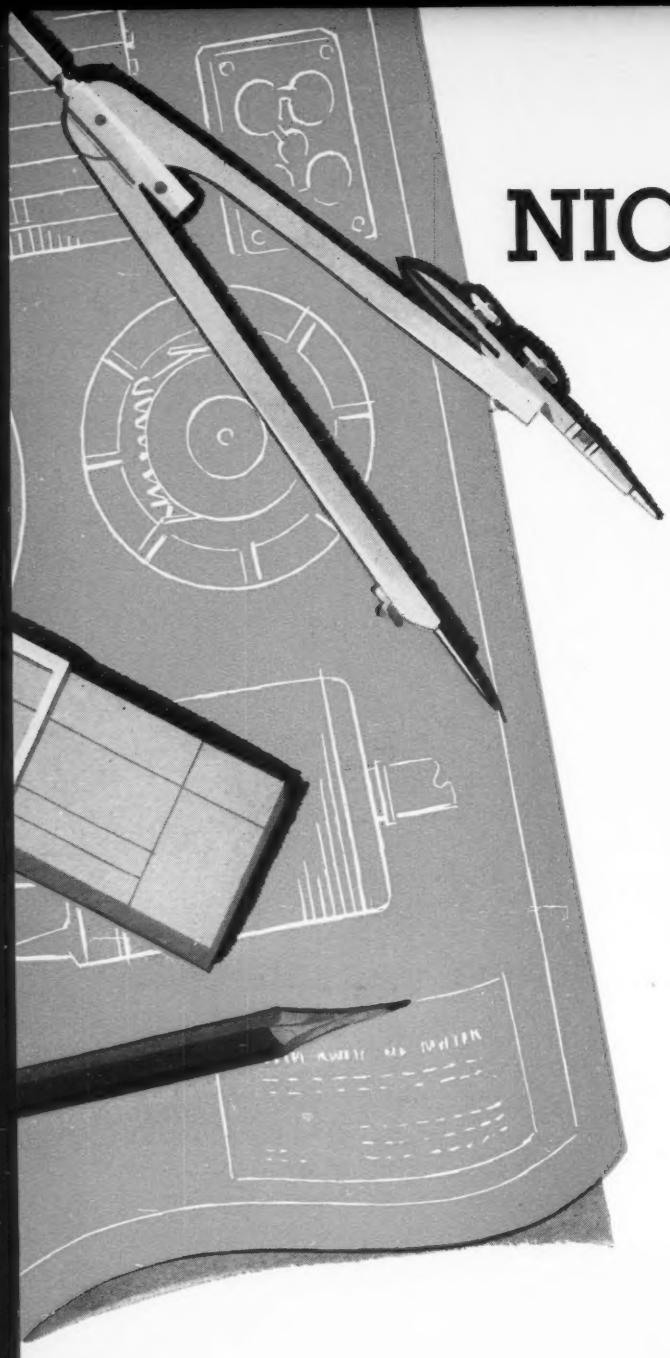
• • •

Photostress

The design engineer needs some means of checking his assumptions and calculations relative to the distribution of deformations, or strains, which will result from the application of given forces, or stresses upon the structural member he has designed. Photo-elasticity is one such means.

Conventional photo-elasticity, however, permits only an indirect analysis of stress distributions since it involves essentially the analysis of stresses artificially produced in a transparent plastic model of the structure to be stress-investigated.

The Photostress technique is the only one which permits the evaluation of truly punctual elastic and/or plastic deformations on the surface of structures, irrespective of the type of material of which these are made, of their size and shape, and whatever the manner in which the static or dynamic load is applied.



Design with NICKEL STEEL for improved mechanical properties

Nickel is being utilized to assist the design engineer in an ever increasing variety of equipment. It is used extensively in the direct-hardening engineering steels where it greatly improves mechanical properties. Also the nickel-containing carburizing steels are favoured because they distort less in heat treatment and perform better in service, particularly when heavy loads are encountered.

Increased Corrosion Resistance
Proprietary brands of the weldable, low-alloy high-strength steels usually contain nickel. Such steels allow for weight reduction because they have higher yield points than the weldable grades of unalloyed steels. These materials also have better resistance to the corrosion effect of atmospheres than do the weldable grades of unalloyed steels.

Strengthens Matrix
To obtain proper mechanical properties in large forgings is much more difficult than it is in the case of the smaller sections usually involved in rolled steel applications. The properties of large forgings are therefore dependent on the alloy content. Nickel, either alone or in combination with other elements, has been the leader in this field because it strengthens the matrix, independent of the carbon content or heat treatment.

Increases Toughness at Low Temperature
Nickel definitely lowers the temperature at which brittle failure occurs in steel and is certainly the most potent element in this ability.

Many designers probably are unaware of the fact that good low temperature properties also indicate the suitability of a steel for use at ordinary temperatures under conditions of high stress concentration or rapid rates of loading.

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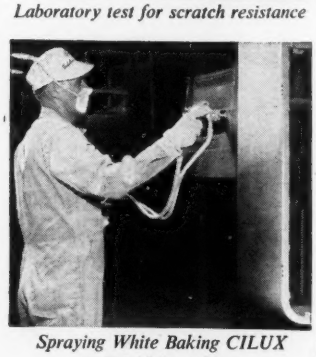

Spraying White Baking CILUX on Frigidaire cabinet

FRIGIDAIRE Uses CILUX White Baking Enamel

To put the finishing touch of beauty in modern kitchens, C-I-L developed White Baking CILUX, seen here on the famous FRIGIDAIRE refrigerator. Like other C-I-L industrial finishes — CILUX White Baking Enamel has *unexcelled* scratch and mar-resistant qualities and retains its original whiteness. It was developed to exacting customer specifications.

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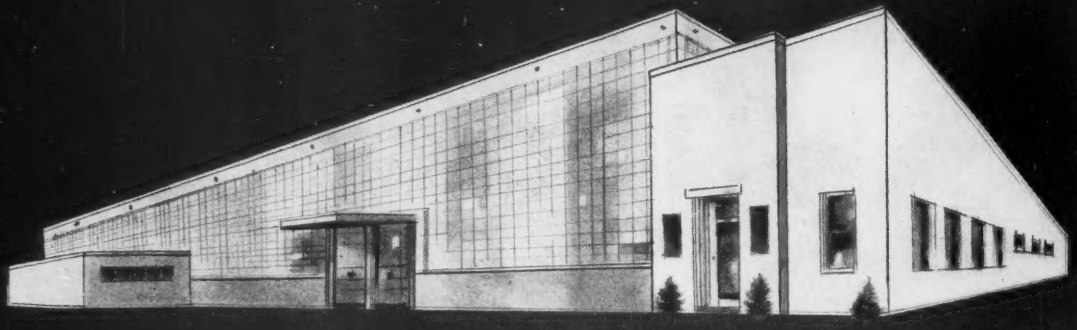

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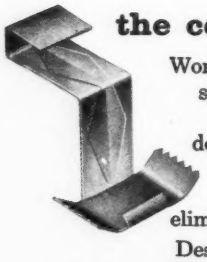

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the construction industry profits . . .

Working with ROBERTSON-IRWIN LIMITED, a major supplier of steel roof deck to the Canadian construction industry, Dominion Fasteners Limited created and developed a new type SPEED CLIP for the attachment of insulation to roof deck. The precarious fire hazard associated with former methods was completely eliminated . . . as well as many other installation problems.

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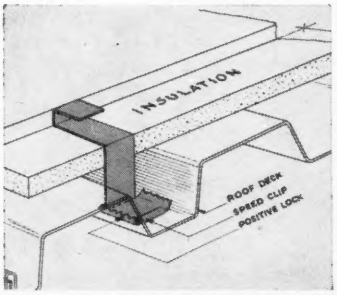

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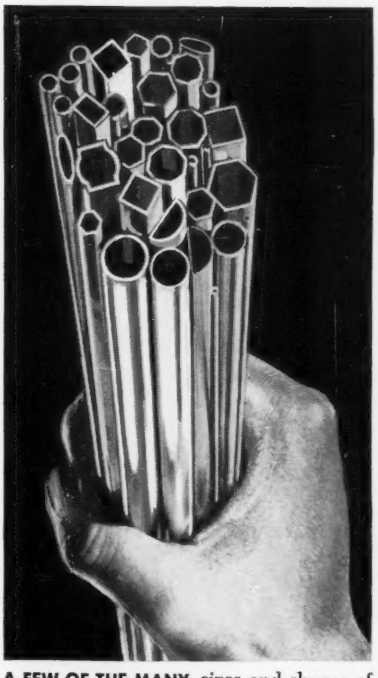

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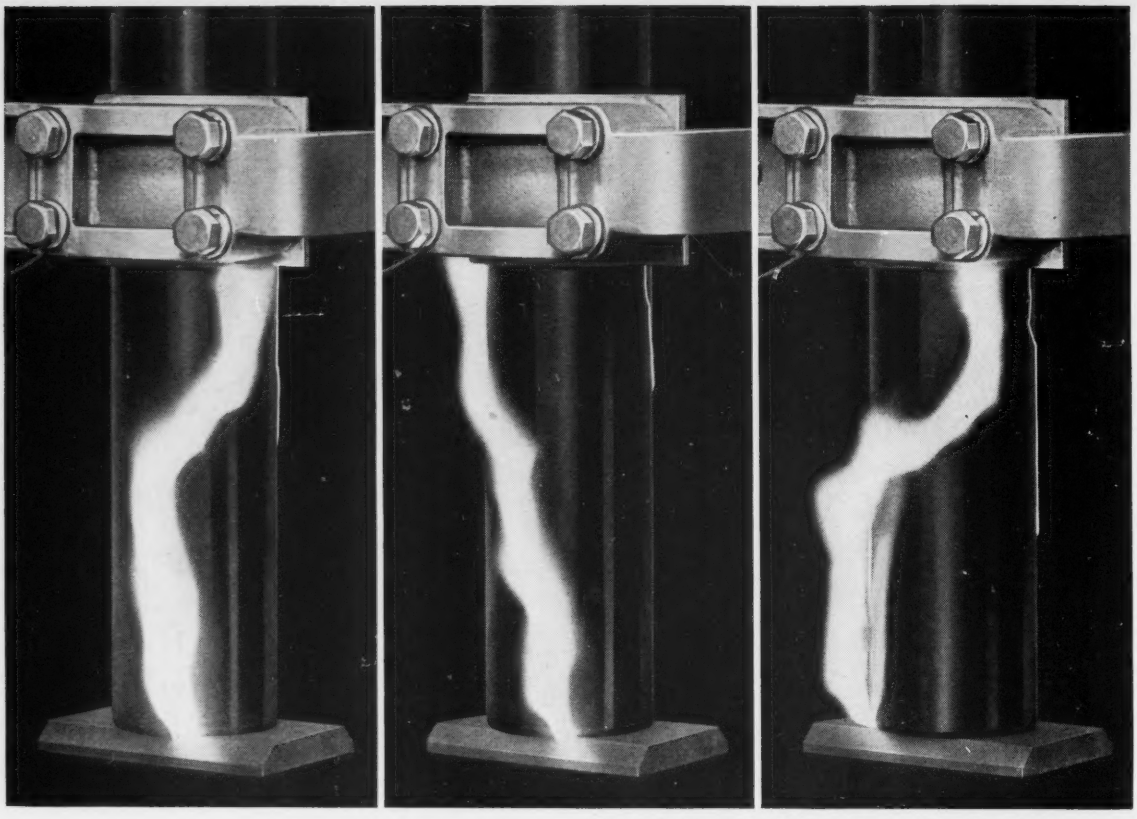

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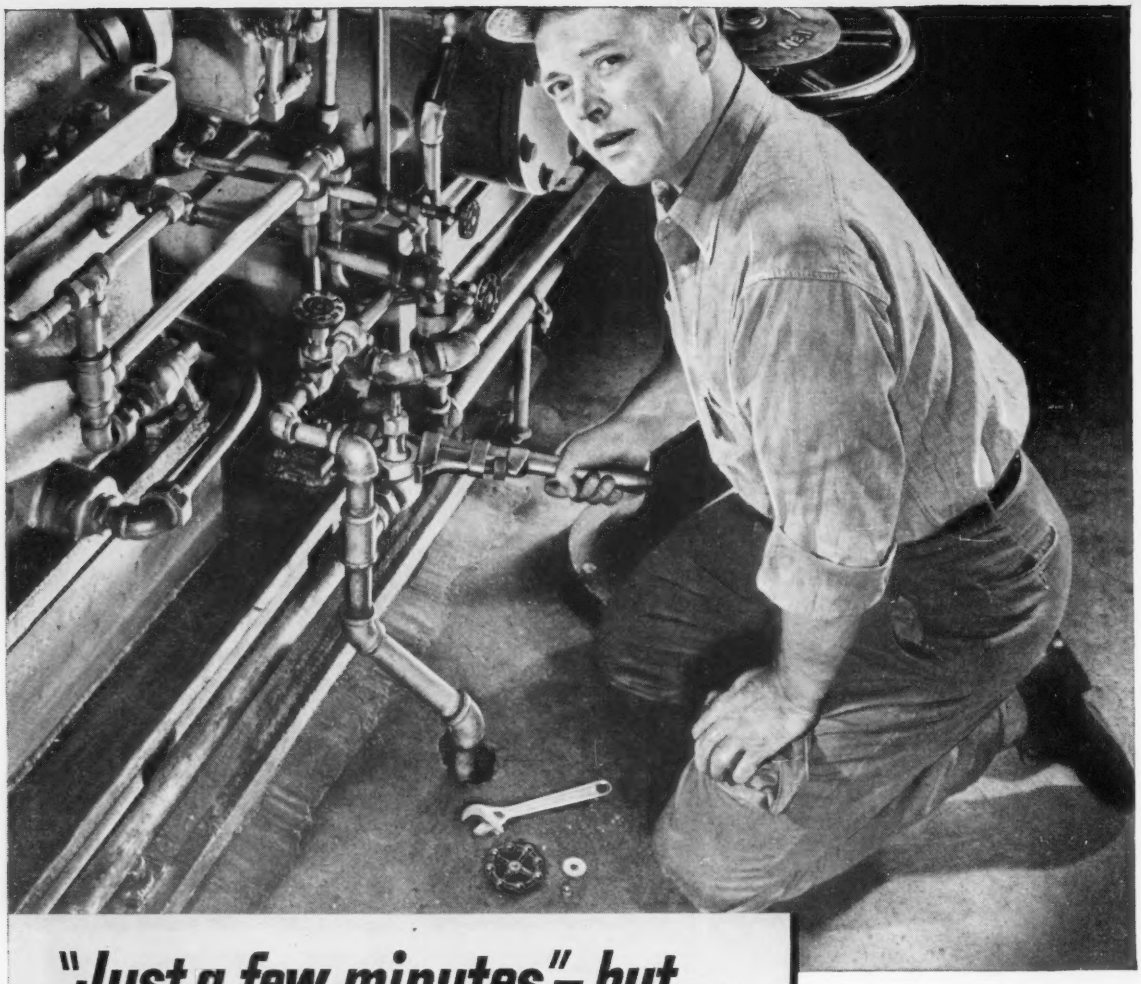

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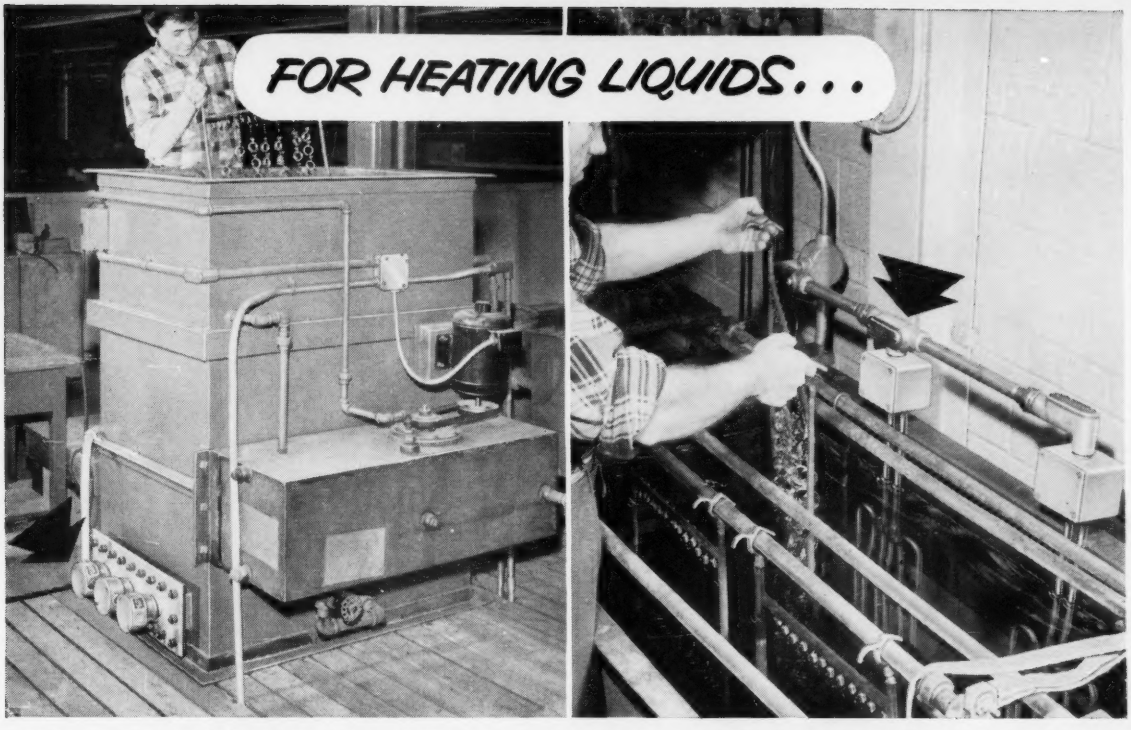

This degreaser unit is fitted with three 6kw steel sheathed Calrod "screw-in" heaters.

A rack of costume jewellery is here seen being lowered into a copper plating tank. The contents of the tank are heated by two 6kw steel sheathed Calrod "over-the-side" heaters.

Canadian Hanson and Van Winkle chose G-E Calrod Immersion Heaters for dependability and efficiency!

Canadian Hanson and Van Winkle chose General Electric Calrod Immersion Heaters for the cleaning, degreasing and plating tanks they designed and built for the new plating room at Coro (Canada) Ltd., one of Canada's largest costume jewellery manufacturers. Commenting on their choice, they said:

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Learn how Clipper Seals' many advantages can cut costs for you . . . by simplifying design problems, speeding assembly and providing improved lubricant retention and dirt exclusion under all conditions. Write for free brochure PK-71A to Canadian Johns-Manville Co., Limited, 565 Lakeshore Road East, Port Credit, Ontario. Dept. 6456

Johns-Manville CLIPPER SEALS

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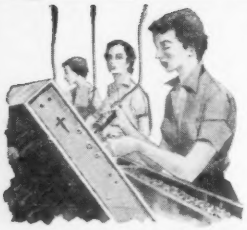
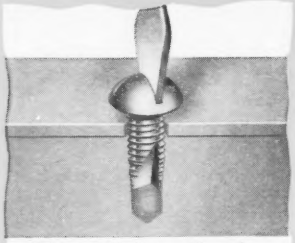
Why

SHAKEPROOF® THREAD-CUTTING SCREWS

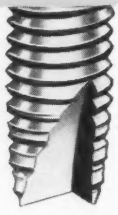
give a better fastening... faster!



Shakeproof Thread-Cutting Screws offer you immediate assembly savings.

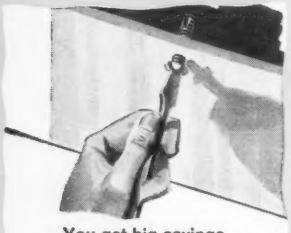


They cut their own threads, eliminate separate tapping operations completely.

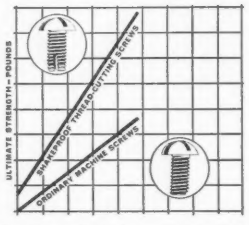


This thread-cutting slot exposes a sharp, serrated cutting edge.

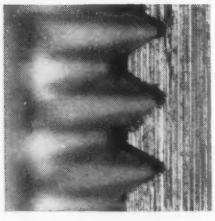
Shakeproof Thread-Cutting Screws actually work with true tapping action.



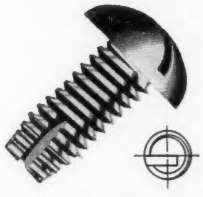
You get big savings. Just drill or punch hole and drive—that's all! No tapping, no tapping tools!



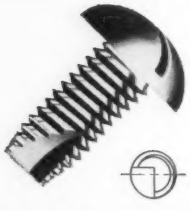
These hardened screws provide greater strength . . . often permit use of smaller sizes.



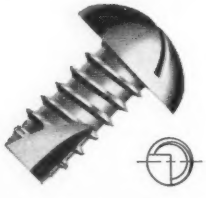
Self-cut mating threads assure a tight, vibration resistant fit.



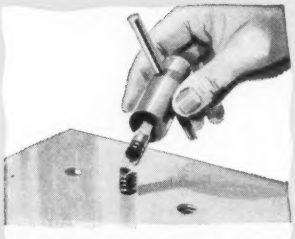
Type 1 Thread-Cutting Screws are specially designed for use in hard metals.



Type 23, with wider thread-cutting slot, is for use in metals and plastics.



Type 25, with spaced thread, is designed for use with plastic materials.



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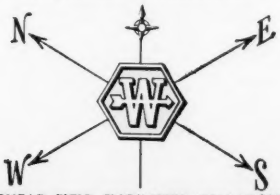
Line-to-line seal between tube and cutting edge of patented ERMETO sleeve.
Line-to-line seal between ERMETO sleeve and fitting body.

Faster Installation
Trouble-free Service

With Weatherhead Ermeto you install high-pressure injection lines without upsetting tube ends . . . eliminate flaring, threading, welding or soldering on other connections. When the nut is tightened, the patent Ermeto sleeve shears a groove into the outside of the tube to form a positive seal that defies vibration and pressure. You can uncouple and reassemble the joint over and over. Weatherhead makes Ermeto in steel and stainless steel; hose assemblies with Ermeto ends are available on special order. Weatherhead also supplies tools to reseat any standard nozzle or pump for Ermeto connectors.

WHO USES ERMETO? All the leading organizations in a score of industries. They specify Weatherhead's Ermeto for their regular production, for defense work, in fact, for every application where they want to be sure of dependable connections.



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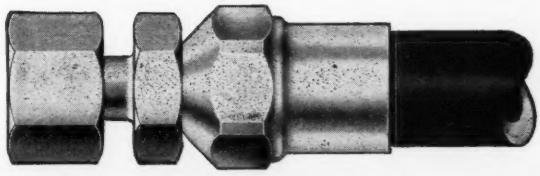

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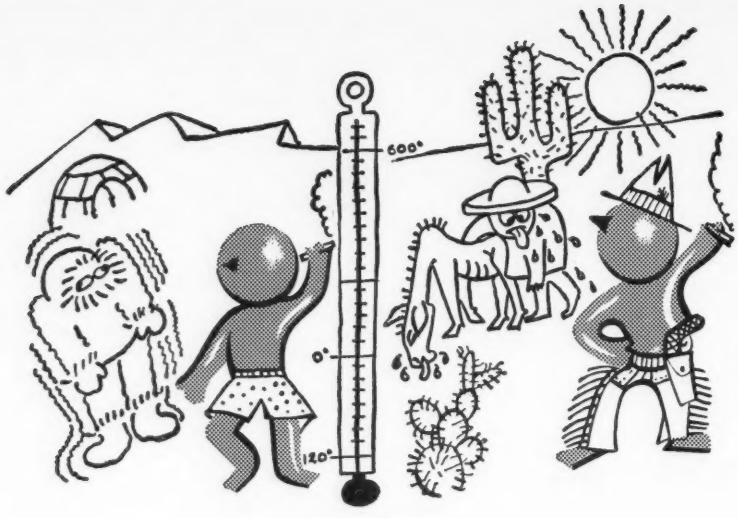

G-E Silicones revel in temperature extremes . . .

At both ends of the thermometer—from 120° below zero to blistering 600°F—G-E Silicones seem to revel in temperature extremes. Industrial and product designers find that Silicones shrug off the ravages of heat and cold that once limited the usefulness of many products and manufacturing processes. Perhaps one of these compounds will help improve your products.

For instance, G-E Silicone Rubbers stand up to 600°F. They will not crack, decompose or become sticky when used as seals and gaskets in jet and diesel engines, electrical appliances and similar "hot" equipment. As bomb-bay door stripping on high altitude planes they are still flexible at 120° below zero.

G-E Silicone Oils and Hydraulic Fluids change very little in viscosity over a wide temperature range. Most petroleum oils will not operate at 50° below zero, while Silicone oils pour freely at 120° below.

In paints and electrical varnishes, G-E Silicone Resins will not flake, discolor or decompose at extremely high temperatures. On exhaust stacks, appliances, furnaces and heaters, colored finishes stand up to 600°F, aluminum finishes up to 1000°F.

There are many G-E Silicone compounds, each formulated for a wide variety of properties and characteristics. You owe it to your business to explore their possible usefulness in your production and for your products.

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DU PONT CANADA

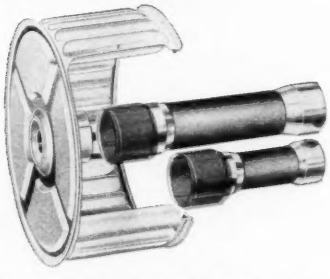
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

Brydon Brass Mfg. Co. Ltd. of Toronto, Ont. Uses "Zytel" 101 Nylon Resin for New Type Water Ski Accessories

Splined sleeve for new flexible coupling molded of tough ZYTEL® nylon resin

Now, molded ZYTEL nylon resin, with its outstanding wear resistance, toughness, strength in thin sections and freedom from need of lubrication, brings improved performance to this oil burner drive. A splined sleeve of ZYTEL offers continuous high-slip, lateral motion, and low-friction surface which will not gall on the blower wheel hub.



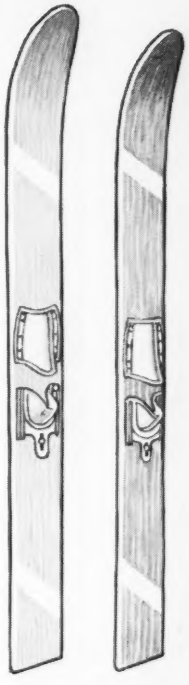
Blower wheel to which flexible couplings attach in gun-type oil burners. Also pictured are two coupling sizes with new splined sleeve of ZYTEL indicated in red. (Manufactured by Guardian Products Corporation, Coupling Division, Michigan City, Indiana.)

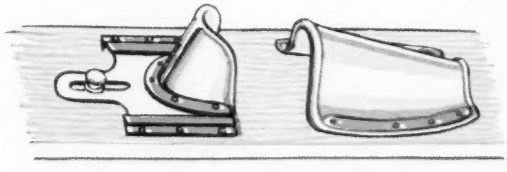
Du Pont ZYTEL replaces the aluminum drawn tubing which was previously standard in this application. The ability of ZYTEL to be molded to close tolerances enables the sleeve to offer tight, minimum-diameter clearances. Also, ZYTEL is impervious to fuel oils and stable at elevated temperatures. It offers silent, smooth operation for many years of trouble-free service.

From the initial molding process to the installation of the coupling, ZYTEL offers cost savings to both manufacturer and users. ZYTEL is easily and inexpensively injection molded and requires no further finishing. Installation and downtime are considerably reduced. Perhaps your product could be improved with a proper application of Du Pont ZYTEL. For further property data and application information, clip and mail the coupon on the other side of this page.

In the design of their all-new "Brydon Boy" water ski harness, Brydon Brass Mfg. Co. Ltd. of Toronto, Ontario, has turned to versatile "Zytel" 101 nylon resin for moulded parts which meet the high specifications of toughness, durability and economy essential for this application.

"Zytel" 101 nylon resin, soon to be produced in Canada by Du Pont Company of Canada Limited, possesses exceptional engineering qualities which to date have resulted in over 5,000 known uses of this plastic material in a wide variety of mechanical parts. The Brydon water ski is an all-Canadian development in a new field where the emphasis is on design, workmanship and serviceability.





The "Brydon Boy" B-110 Ski Harness uses nylon "clips" where the maximum stress is experienced in water skiing. These moulded parts of "Zytel" 101 replace aluminum stampings which were formerly used to anchor the soft, flexible toe and heel pieces to the skis. They are corrosion-proof and fully adjustable for comfort and safety. Two curved pieces hold the toe cap rigidly in position, while the back assembly is adjustable and consists of four pieces (two straight fixtures on each edge, a horse-shoe shaped part along the base of the heel cap and, a sliding piece for adjustment). The "Zytel" parts for this "Brydon Boy" B-110 Ski Harness are moulded by Toronto Plastics, 309 Pharmacy Ave., Toronto, Ontario, who are widely experienced in the production of moulded mechanical parts of nylon.

The skis themselves consist of five-ply selected ash veneer and two-ply of mahogany on the outside. They are reinforced with fibre glass, varnished and decorated with colored tapes. The Brydon equipment also includes 72 feet length of tow rope with handle.

Brydon water skis, incorporating the new-design, nylon-reinforced harness, have met with a ready response and increased production is forecast to meet next year's demand.

"Teflon", "Zytel", "Alathon" and "Lucite" are registered trade-marks of E.I. du Pont de Nemours & Co. (Inc.)

DU PONT CANADA

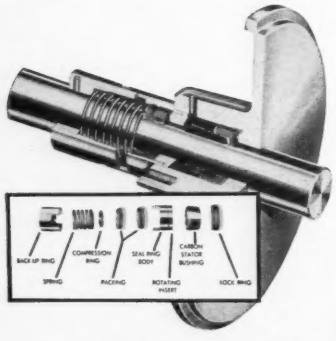
PRODUCT ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE ENGINEERING MATERIALS: "ZYTEL," "ALATHON," "TEFLON," "LUCITE."

TEFLON® simplifies design and reduces costs in mechanical seals

LATEST design in mechanical seals features complete and rapid interchangeability with packing. Developed by Chemical and Power Products, Inc., New York City, this new seal can be made to fit any stuffing box, requiring no alterations or special clamps. It offers economy by eliminating product loss and minimizing installation and downtime.

TEFLON tetrafluoroethylene resin plays the feature role in the sealing of corrosive liquids and slurries. TEFLON is used as a shaft packing in the form of a male and female cup, providing maximum flexibility with minimum spring pressure as a wedgelock in the bottom of the seal to prevent leakage and stop rotation of the stator. The self-aligning wedgelock of TEFLON slips easily in place, and the time and expense involved in installing a clamp to hold the stator are eliminated.



TEFLON is selected in many sealing applications because of its superior physical and chemical properties. TEFLON is chemically inert, and will operate within extreme service temperatures ranging from −450°F. to 500°F. It is nonflammable, has zero water absorption, has low-temperature toughness and a low coefficient of friction.

A proper application of TEFLON can help you solve design problems involving extreme heat or corrosion.

New valve housing economically molded of Du Pont ZYTEL® nylon resin

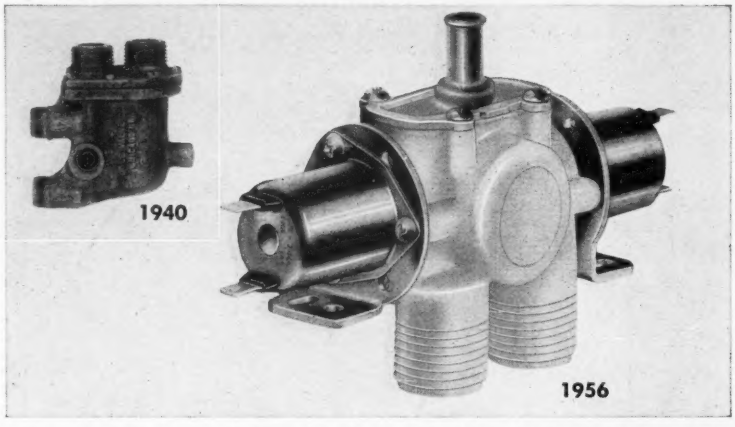
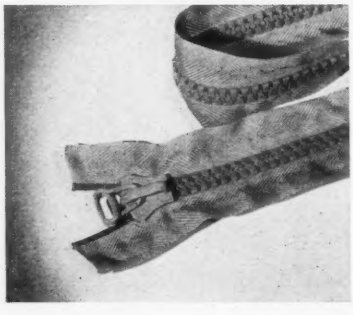


Illustration shows design change in thermostatically operated water control unit in past sixteen years. A housing of ZYTEL has replaced brass in this modern automatic home washing machine valve. (Housing molded by Chicago Molded Products Corp., Chicago 57, for The Dole Valve Co., Chicago 12, Illinois.)

THE unique properties of ZYTEL nylon resin make it particularly adaptable to this new valve body design. ZYTEL is easily injection molded to close tolerances. ZYTEL is tough, abrasion resistant, strong in thin sections, light in weight and offers good chemical resistance. It provides quiet operation with little or no lubrication, and possesses good insulating characteristics.

The molded threads on the two inlets in the thermostatically operated water control unit pictured above provide a strong, leak-proof connection when used with a standard hose coupling. The resistance of ZYTEL to water and chemicals prevents corrosion. In hard-water areas, these valve bodies are unaffected by deteriorating action of minerals present.

Slide fasteners of ZYTEL have been designed for use in a wide variety of military and consumer goods. Fasteners operate smoothly, even in extremes of temperatures . . . are resistant to mildew, corrosion and chemicals. They can be molded in a broad range of colors. (Manufactured by Waldes Kohinoor, Inc., Long Island City 1, N. Y.)



DU PONT COMPANY OF CANADA LIMITED,
CHEMICALS DEPARTMENT, Room A-4, P.O. Box 660, MONTREAL, QUE.

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Please send me more information on the Du Pont engineering materials checked: ☐ ***"Zytel"***; ☐ ***"Alathon"***; ☐ ***"Teflon"***; ☐ ***"Lucite". I am interested in evaluating these materials for:***

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Investigate DuPont engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design. The wide range of properties available with ALATHON® polyethylene resin, LUCITE® acrylic resin, TEFLON® tetrafluoroethylene resin, and ZYTEL® nylon resin are helping solve industrial design problems.

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at each end of the linkage connecting the bellcrank and the piston wrist pin, operate the all-important air pump in this Technicon-Huxley Chest-Abdomen Respirator. In this application, the Heim Rod Ends eliminate all bind in the reciprocating piston and all noise and play, even after long and constant use.

This respirator, made by Conitech, Chauncey, N. Y., is completely portable and is an improvement over the iron lung, as it leaves the upper and lower extremities of the patient free, permitting sitting-up, exercising of the limbs, and nursing care. Constructed for long-time continuous operation, the power unit is a positive displacement piston mechanism, operated by the Heim Rod Ends, which delivers a volume of about 1100 cu. in. per stroke.

Heim has an informative, illustrated catalog of Unibal Bearings and Rod Ends as well as all other Heim bearings. Send for your copy and use Heim's engineering service for any linkage problem.

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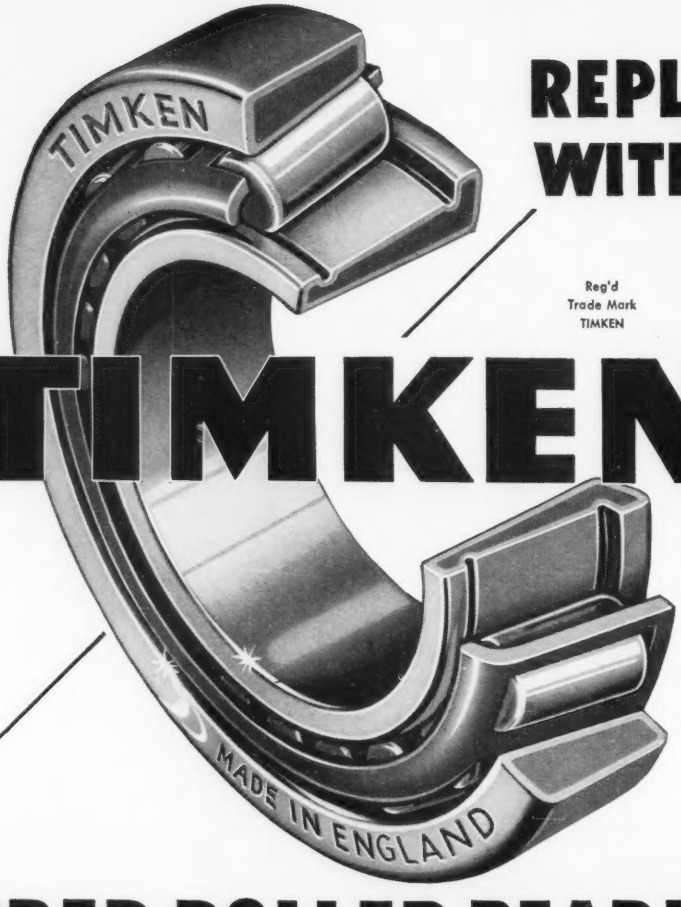

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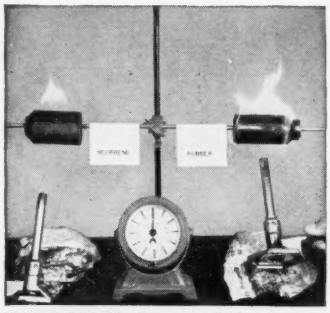
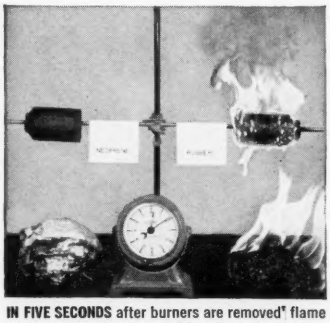
NEOPRENE ROLLERS PASS FLAME TEST!



PRINTING ROLLERS of neoprene (left) and natural rubber (right) are exposed to the flame of Bunsen burners until they ignite.



IN FIVE SECONDS after burners are removed flame on neoprene roller is out. After 69 seconds, drippings from flaming rubber roller have ignited newspaper.

This test convinced management of the New York *Daily News* that neoprene printing rollers offer an extra measure of safety over natural rubber. Today, they flame test all rollers before they buy—and neoprene rollers are the only rollers that meet the test.

Neoprene's resistance to flame may well be useful to you as an added safety factor in your product designs. And neoprene offers resistance to abrasion, oil, heat, and chemicals as well. For all general-purpose applications, you can count on neoprene for long-term service. Clip coupon for further information.

Resilient gaskets of HYPALON unaffected by 2% ozone

Re-usable after 2 years in ozone generators

For two years now Emery Industries has been using HYPALON synthetic rubber gaskets to seal its ozone generators. The company's ozone-producing installation is the largest in the country. Its operations supervisor, Robert Peters, made this report on HYPALON. "No failures with HYPALON gaskets in two years, even though they've been exposed to 2% ozone."

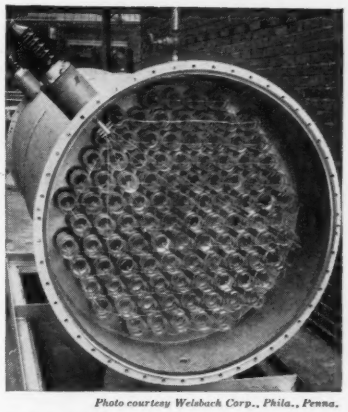


Photo courtesy Welsbach Corp., Phila., Penna.

HYPALON gasket on ozone generator showed no sign of deterioration after two years of service.

Design of the generator

The generator used by Emery Industries consists of a steel shell packed with a series of glass tubes individually encased in an electrically charged metal enclosure. A conductor carries an opposing charge through the glass tubes to make, in effect, a large electrical condenser. Dry oxygen is passed along the length of the glass tubes and converted to ozone. The generators are closed at each end by a dished head sealed with HYPALON gaskets.

HYPALON replaces plastic

Formerly, plastic gaskets were used in the generator. While unaffected by ozone, plastic gaskets had to be replaced after each maintenance checkup because they were too rigid for re-use. HYPALON gaskets, even after two years of service, retain their resilience and are still re-usable. Says the generator manufacturer, Welsbach Corporation, in Philadelphia: "We use HYPALON gaskets because they have the best over-all combination of properties of any we've found—including ozone inertness, resilience and cost."

Designing with HYPALON

HYPALON means extra-long life at lower operating costs for resilient products subject to severe service conditions. It can operate at temperatures from 250°F. to 350°F. It is particularly resistant to most oxidizing chemicals. And HYPALON resists weather and sunlight attack and can be compounded in an unlimited range of stable colors. For more information about HYPALON, clip and mail the coupon below.

DU PONT CANADA

HYPALON *is a registered trademark of E. I. du Pont de Nemours & Co. (Inc.)*

MAIL THIS COUPON TODAY!

DE-1

Please send further information and add my name to the mailing list for your free publications, the "Neoprene Notebook" and "Facts about HYPALON," which show how the Du Pont elastomers are used in designing new products, improving old.

Du Pont Company of Canada Limited,
Chemicals Department, Room A-4,
P.O. Box 660, Montreal, Que.

Name _____ **Position** _____

Firm _____

Address _____

City _____ **Prov.** _____

No rest for this busy solvent!

ACETONE

Of all the solvents available to industry, few work harder or as well as Shell Acetone.

In the preparation of lacquers and lacquer thinners, Shell Acetone can replace as much as 30% of the conventional low-boiling active solvents at half the cost and improve the odour of the product as well.

Because of its high solvent power, Shell Acetone is used in the cellulose acetate rayon industry and in the preparation of paint and varnish removers.

From nail polish remover to tear gas . . . Acetone demonstrates its acceptance as an efficient and economical solvent.

Let us show you how you can increase production and cut manufacturing costs with the wide range of Shell Chemicals. Telephone or write your Shell Chemical Representative or contact Shell Oil Company of Canada, Limited.

Some other Chemicals produced by Shell for industry are:

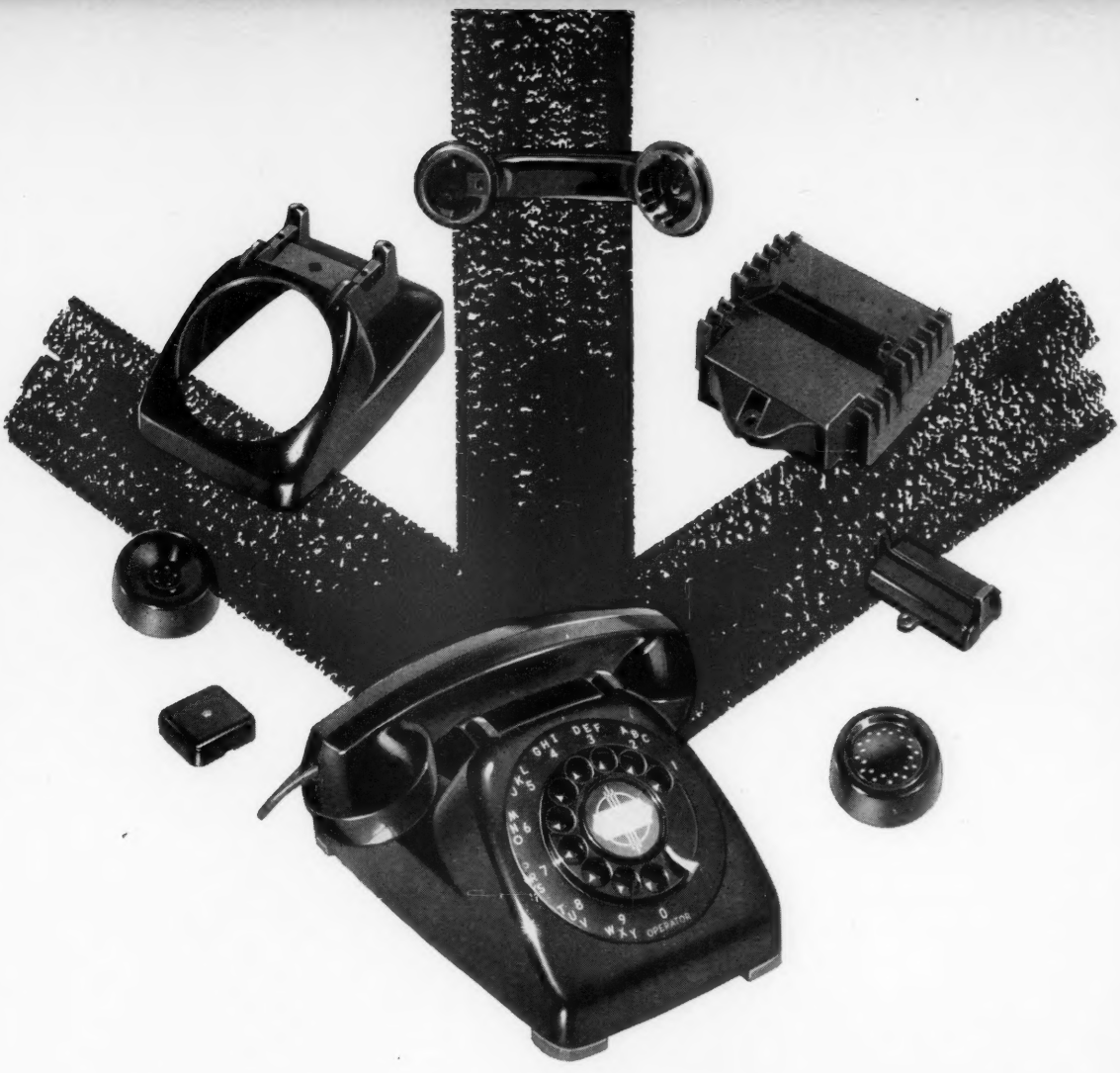
Methyl Isobutyl Carbinol
Methyl Isobutyl Ketone
Methyl Ethyl Ketone
Isopropyl Alcohol
Diacetone Alcohol

SHELL

Chemical Division

SHELL OIL COMPANY OF CANADA, LIMITED

TORONTO MONTREAL VANCOUVER



Intricate molding operation performed for Automatic Electric (Canada) Limited

The Automatic Electric Type 80 Telephone, above, the second model molded for this Company . . . is typical of the repeat-order confidence customers have in Canadian General Electric.

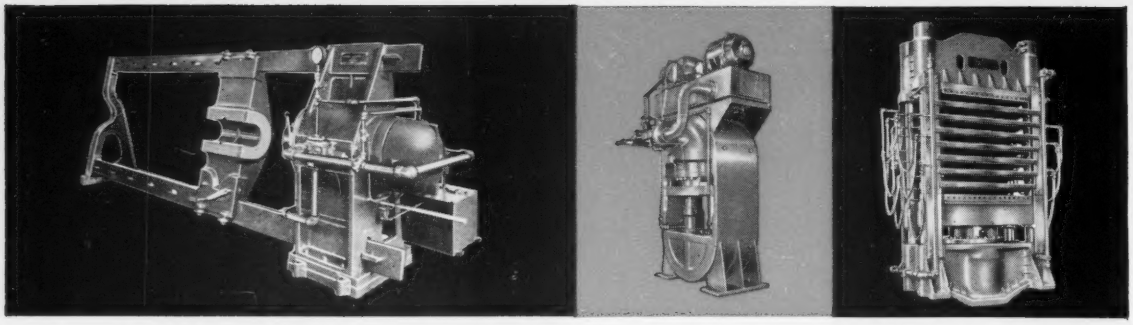
Time after time these customers return to Canadian General Electric Plastics Advisory staff with problems involving plastics. Job after job they profit from the design ingenuity, wide material and process versatility, and the experience, progressive research and practical knowledge that has made C.G.E. one of Canada's oldest, largest and busiest molders of plastics.

Plastics Advisory Service—No matter what your requirements this "specialist" Service will pay off for you, too. Whether the job calls for an entirely new material, product, or part or simply the need to improve the visual or functional design of an old product, C-G-E engineers range through every known raw material and filler, and every method of molding—injection, compression, extrusion, including automatic molding. One or all of these methods may be required to produce parts for a final product that is better made . . . at lower cost . . . with fewer rejects. *For complete information: contact Plastics Advisory Service, Canadian General Electric Company Limited, Cobourg, Ontario.*

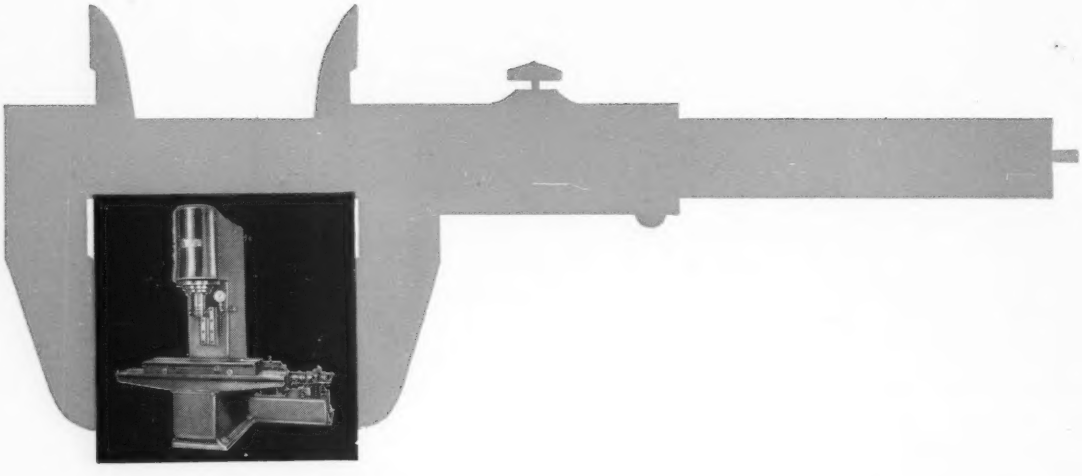
CUSTOM MOLDED PLASTICS

451W-156

CANADIAN GENERAL ELECTRIC COMPANY LIMITED



Specialists in the design
and production of Hydraulic Machinery
for all industrial purposes.



HYMAC Hydraulic Machinery designed to your specifications
saves time, reduces costs, increases production.
HYMAC specialists available for consultation and service
. . . write or 'phone for further information.

HYMAC
1906 - 50th ANNIVERSARY - 1956

HYDRAULIC MACHINERY COMPANY LIMITED
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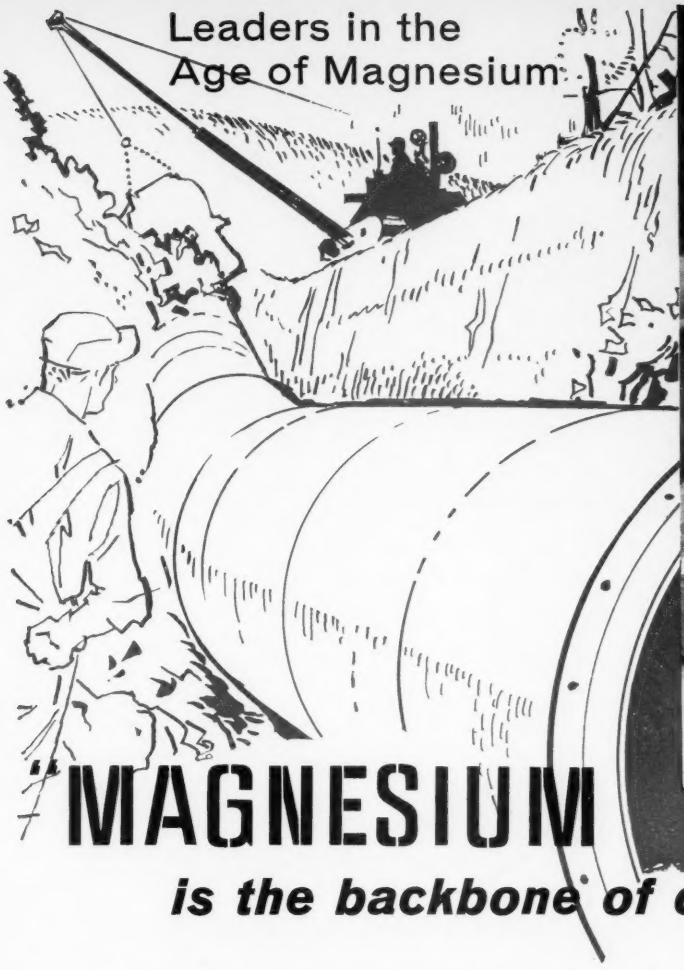
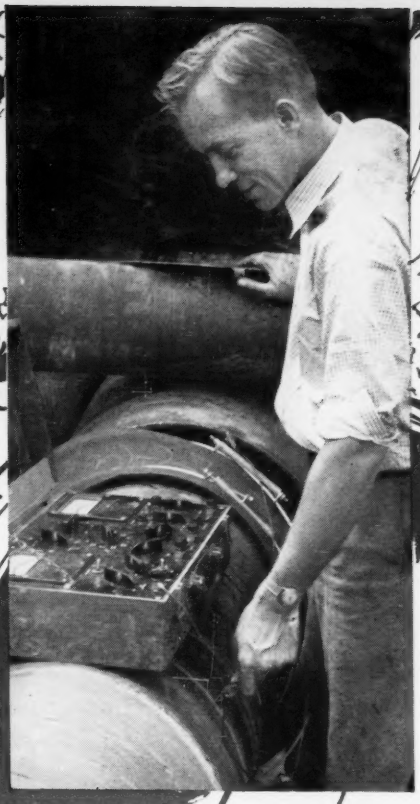
Hydraulic Presses, Pumps, Accumulators, Valves and Fittings • Pulp & Paper Mill Machinery • Special Machinery to Specification

Leaders in the
Age of Magnesium





"MAGNESIUM *is the backbone of our business"*

States T. R. B. Watson,
Corrosion Engineer,
Corrosion Services Ltd.,
Toronto, Ontario

"We started our business using Domal Magnesium because of its exceptional purity. Increasing quantities have been used in our protective installations both for pipelines and marine structures. Magnesium anodes are quick and easy to install and experience has proved them to be very effective."

From jet planes and heavy structural equipment to increasing numbers of household products . . . wherever lightness, strength, durability and versatility are demanded, modern engineers are finding more and more uses for

DOMAL
HIGH-PURITY
MAGNESIUM

THE WORLD'S LIGHTEST, MOST VERSATILE METAL

DOMINION **MAGNESIUM** LIMITED

320 BAY STREET · TORONTO, CANADA

The original engravings for this advertisement were made on magnesium

This is a Tycoon

(in a receptive mood)

who knows what he wants

(quality machined castings)

when he wants it

(the day before yesterday)

and how to get it

(from Wallaceburg, naturally)

The day before yesterday is difficult, but Wallaceburg has sometimes worked *near* miracles for customers. For fifty years, hundreds of leading Canadian businesses have been calling in the man from Wallaceburg to supply component parts. For two very good reasons—quality and service. Fast, dependable, complete service.

Now, with Wallaceburg-Singer Limited, producing Cored Brass Forgings, we've more than ever to offer. Call us for Die Castings in zinc and aluminum, Machined Sand Castings in brass and bronze, Cored Brass Forgings and Automatic Screw Machine Products in brass, steel and aluminum. **And because we have all these processes, we'll honestly and intelligently tell you which is right for your component.**

WALLACEBURG
BRASS LIMITED
WALLACEBURG, ONTARIO

AND AFFILIATED COMPANIES
WALLACEBURG-SINGER LIMITED
DOMINION DIE CASTING LIMITED

BRANCHES: MONTREAL, TORONTO, MONCTON, LONDON, WINNIPEG, CALGARY, VANCOUVER

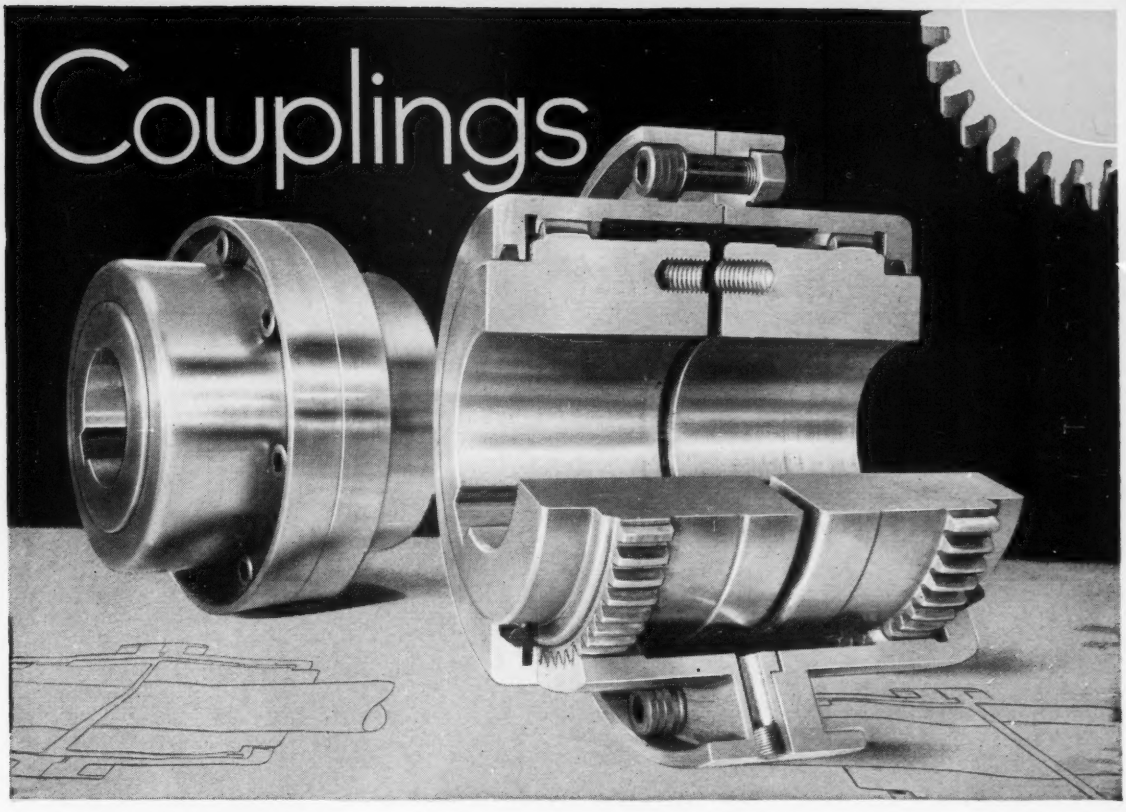


Fig. 1 shows a gear type coupling with the shafts in correct alignment.

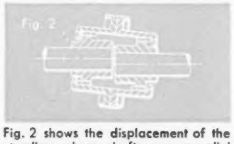


Fig. 2 shows the displacement of the coupling where shafts are parallel but out of line.

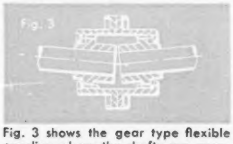


Fig. 3 shows the gear type flexible coupling where the shafts are angularly out of line.

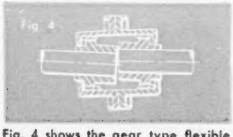


Fig. 4 shows the gear type flexible coupling coping with a combination of errors of alignment both angular and offset.

Hamilgear Flexible Couplings

HAMILGEAR flexible couplings are of modern compact design combining all the desirable features necessary to insure long trouble free operation and maximum load carrying capacity for all possible conditions of misalignment shown at the left.

Tooth flanks of the external teeth on the hubs are crowned to give a "barrel" shape. The amount of curvature is proportioned to balance the requirements of eliminating edge tooth contact when connecting misaligned shafts, and still assure maximum load carrying capacity with minimum tooth stress.

The internal gear sections are widely spaced to keep the angularity resulting from offset misalignment at a minimum.

Shear stress on the flange bolts is taken on the full bolt diameter rather than on the threaded portion.

Lubricant is retained in the coupling and dust and dirt excluded by oil resistant synthetic rubber "O" rings.

HAMILGEAR flexible couplings are available in stock sizes and types and special designs where required.

Hamilton Gear
and Machine Co., Limited.
950•990 DUPONT ST., TORONTO 4

MONTREAL office—6785 Upper Lachine Road
WINNIPEG office—The Cuthbert Company Ltd., 19 MacPhillips St.
EDMONTON office—John H. Ross and Co. Ltd., 6803 - 104th St.
VANCOUVER office—B.C. Conveying Machinery Ltd., 3300 Fraser St.

HGT-5-56

Flexible Couplings

Racks

Helical Gear Reducers

Helical Gears

Spur Gears

Bevel Gears

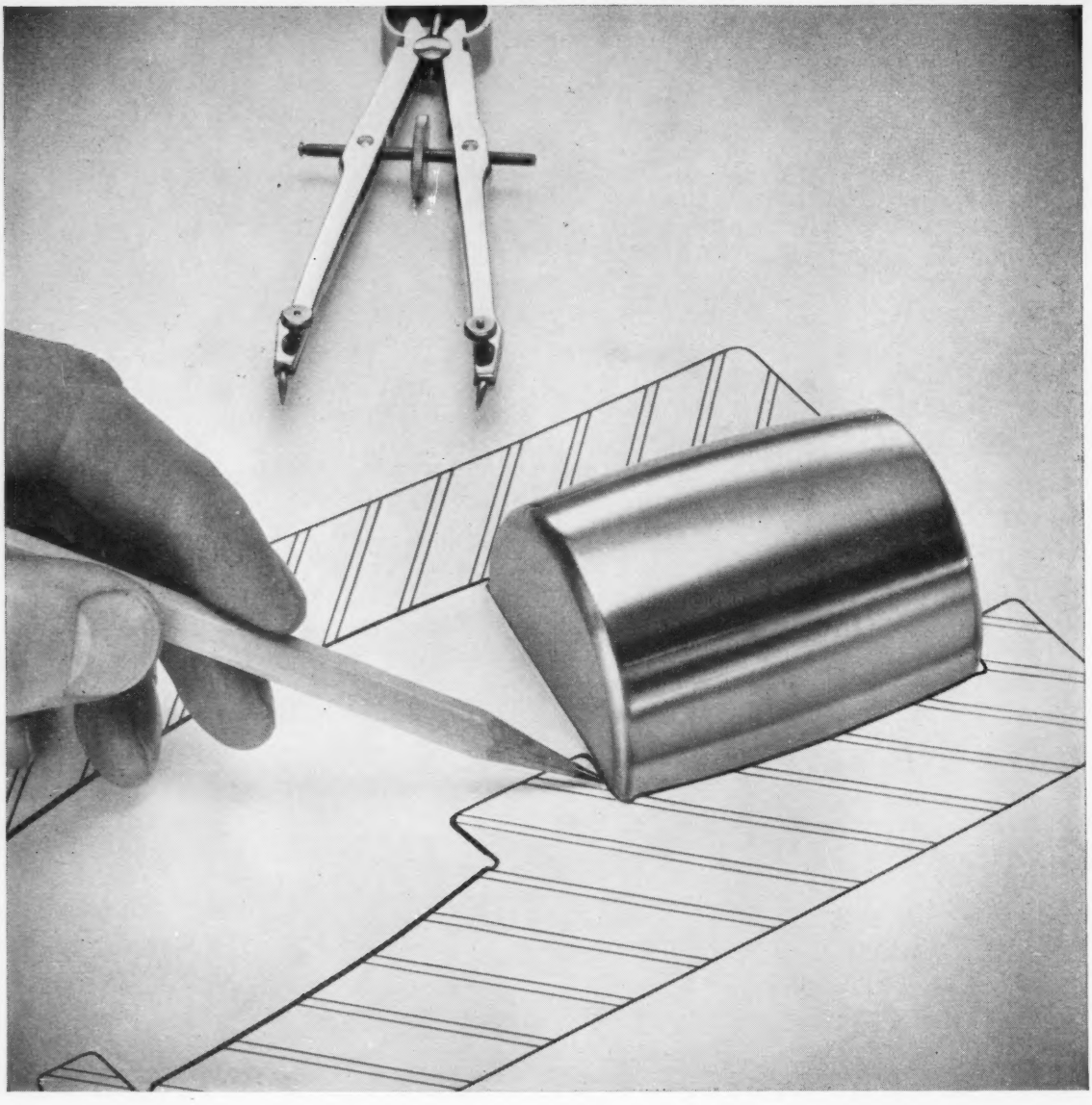
Herringbone Gears

Worms and Wormgears

Internal Gears

Wormgear Reducers

TORRINGTON *SPHERICAL ROLLER* BEARINGS



What a difference *conformity* makes!

TORRINGTON SPHERICAL ROLLER BEARINGS have the right degree of conformity between rollers and races and between roller ends and the center guide flange. "Skewing" is eliminated and rollers operate with a minimum of friction. This means even load distribution and long, low-maintenance service.

Because of their excellent performance in heavy-duty application, Torrington Spherical Roller Bearings have won wide acceptance in rock crushers, cranes, paper machinery, drilling rigs, presses—wherever high load capacity is required under conditions of misalignment.

Torrington Spherical Roller Bearings are available with either straight or tapered bore, for shaft or adapter mounting. And Torrington engineers have wide experience in custom-building bearings for special applications. Whenever you need bearings, call on TORRINGTON.

THE TORRINGTON COMPANY, LTD.
925 Millwood Road, Toronto 17, Ont.

District offices and distributors in principal cities of United States and Canada

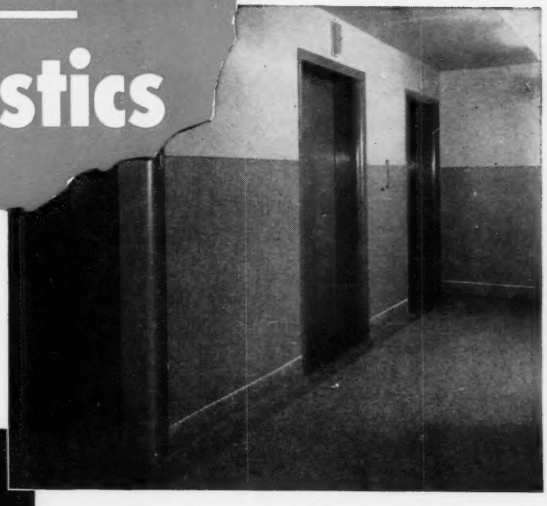
THE TORRINGTON COMPANY 90th ANNIVERSARY 1866-1956

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller Needle • Ball • Needle Rollers

3 NEW applications for BAKELITE plastics

TRADE MARK



Armobond is a tough, durable, fiberglass reinforced wall covering manufactured by Paul Collet & Co. Ltd. A pigmented mix of "Bakelite" epoxy resin is brushed on the wall surface, the glass fiber cloth is then laid up and additional layers of "Bakelite" epoxy resin follow. The whole mass cures in about six hours at room temperature.

Canadair Limited find there are great savings in tooling costs using "Bakelite" epoxy resins for metal-forming dies and fixtures. These resins can be cast into dies without applied heat or pressure using moulds of plaster, wood or metal. Minute mould details are accurately reproduced and the resulting tools are light in weight with excellent impact, flexural and compressive strengths.

The Room Dividers manufactured by Graham Industries are basically patterned fabrics impregnated with "Bakelite" polyester resins and then formed into shapes that are curved, flat or corrugated. These beautiful decorative screens are supplied complete with frames.

These are only a few of the hundreds of applications made possible with "Bakelite" materials. The success of your product depends largely on the selection of the proper material. Bakelite Company offers a wide choice of plastic materials, as well as the guidance of technical representatives. Both these are backed by extensive research and development facilities. Write for full information—

"Bakelite" is a registered Trade Mark

BAKELITE COMPANY

Division of Union Carbide Canada Limited

UCC

BELLEVILLE, ONTARIO

Sales Headquarters:
40 St. Clair Ave. East, Toronto 7
Telephone WAlnut 4-2119

Sales Office:
1425 Mountain Street, Montreal 25
Telephone HArbour 3145

THE BIG WIND IN CANADA

Now available to major producers of heavy-duty air moving equipment: an important new Torrington line of complete blower units for domestic heating, central air-conditioning and other high-capacity cooling. The new units are available in these sizes:

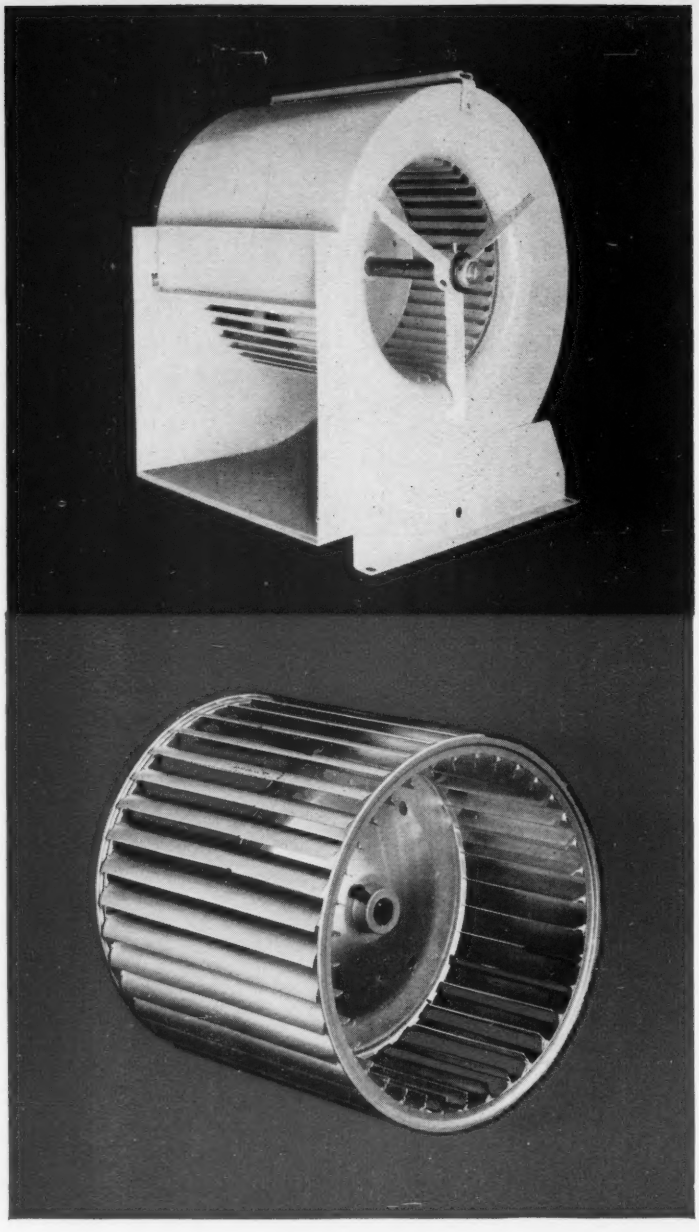
9½" x 9½"	10⅝" x 8"
9½" x 7⅛"	12⅝" x 12⅝"
10⅝" x 10⅝"	12⅝" x 9½"

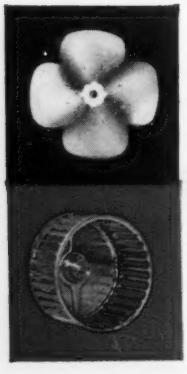
Many advanced construction features are incorporated in all units. In addition, Torrington introduces an entirely new principle of blower wheel construction:

The center disc is dovetailed under pressure into the encircling blades. As a result, the interlocking joint tightens under centrifugal force, thus eliminating blade rattle and angle warp at high speeds.

The advanced engineering behind this announcement is backed by Torrington research and development of air impellers now contributing to the success of products valued at nearly 4 billion dollars a year.

Quite a breeze!...Your inquiries are invited.





THE
TORRINGTON
MANUFACTURING COMPANY OF CANADA LIMITED
OAKVILLE, ONTARIO
TORRINGTON, CONNECTICUT · VAN NUYS CALIFORNIA

People

Important people who are in the news

Douglas G. Darling, P.Eng., has been appointed president and general manager of the Wayne Forge and Machine Co. Ltd., Toronto. The company manufactures an extensive line of industrial and commercial gas-heated processing equipment. President Darling is a graduate in mechanical engineering from the University of Toronto and has received the degree M.A. Sc. from the same university.

Prior to his appointment he was chief engineer of the Toronto Brick Co.

He has been chairman of the Ontario Section of the American Society of Mechanical Engineers and is a member of both the Engineering Institute of Canada and the Association of Professional Engineers of Ontario.

During World War II he served with the engineering branch of the Royal Canadian Navy.

• • •

Chiksan appoints Land

Frank N. Land of Montreal has been named senior field engineer by Chiksan of Canada, Ltd. Land will be available to Chiksan sales representatives in Eastern Canada to provide engineering assistance on all-metal tank truck and tank car loading racks, and for marine and barge loading arms. He will also be available for consultation on in-plant uses of the company's swivel joints, and on the Intelli-Giant hydraulic monitor.

Land joins Chiksan following six years with Lynn Macleod Engineering Supplies, Ltd., a Chiksan sales represenatative, where he was manager of the firm's Morrison Brass Division. He was previously employed for five years by Crane Limited.

A veteran of the Royal Canadian Navy as telegraphist, Land was educated in metallurgy and foundry practice.

He will maintain headquarters in Montreal, working with Lynn MacLeod Engineering in Quebec and the Maritime Provinces, and with G. W. Beecroft Co. of Toronto, in Ontario, Chiksan representatives.

• • •

A new general manager

George Crothers, formerly director of sales, has been appointed general manager of General Controls Co. (Canadian) Ltd. He replaces E. G. Spall, former general manager who headed Perfex Controls in April, 1955.

President W. A. Ray, who made the announcement, expressed optimism for the company's position in the increasingly important Canadian automatic controls market and cited the company's new branch office in Winnipeg as an example of the confidence in the oil and natural gas heating markets.

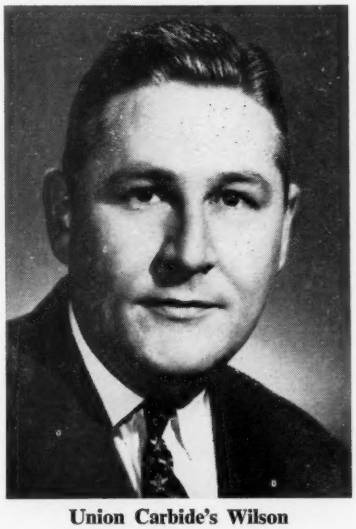
General Controls' manufacturing facilities and Canadian national sales headquarters are at Guelph, Ontario; with factory branch sales offices in Montreal, Toronto and Winnipeg.

• • •

News from Union Carbide

New vice-president at Union Carbide Canada Ltd. is **Mr. F. Perry Wilson,** who also continues as president, Bakelite Company, Division of Union Carbide Canada Limited, Belleville.

V-P Wilson graduated in 1936 in chemical engineering from North Carolina State, and joined the Bakelite organization in 1941. In 1950, he came



Union Carbide's Wilson

to Canada with Bakelite as sales manager. 1953 saw him appointed vice-president in charge of sales, and the following year he became president, Bakelite Company, Division of Union Carbide Canada Limited.

Mr. Wilson is a member of the Society of Plastics Engineers, the Society of Plastics Industry Inc., and of Rotary International.

• • •

Technical manager at Du Pont

In order to give greater technical service to company customers the Du Pont Company of Canada has appointed **T. A. Day** as sales technical manager in the films division.

The division manufactures "Cellophane" cellulose film, polythene film and cellulose sponges and also distributes "Mylar" polyester film and cellulose acetate.

Manager Day's expanded responsibilities will be to co-ordinate and direct both the technical service operations and the customer service packaging laboratory in Montreal. Day, who is a graduate of the University of Toronto, has been with Du Pont since 1948.

• • •

Westinghouse appointments

Two appointments within the engineering department of the Defence Apparatus Division of Canadian Westinghouse have been announced.

J. M. Bester has been named manager of product engineering. Formerly section manager, Industrial Motors and Generators, he will be responsible for product design, planning, administration and operation of the department. A graduate of the University of Toronto, Bester was with General Motors until 1954, when he joined Westinghouse.

At the same time, the appointment of **Mr. M. K. Riddell** to the post of senior project engineer was announced. Riddell joined Westinghouse in 1955 as advisory engineer. He graduated from the University of Toronto in 1948 and spent six years with the Royal Canadian Navy as chief engineer, Electrical Control and Machinery Section. He will be responsible for technical liaison, specifications, technical direction of tests, approvals, systems analysis and customer trials.

• • •

Collins Radio appoints three

Three new appointments within the company are announced by Collins Radio Co. of Canada. Men affected are **Messrs. A. I. O. Davies, A. C. Petrasek and E. H. Edge.** Davies' appointment is that of director of sales. A recent arrival from Britain, he has just terminated 10 years' service with Smiths Aircraft Instruments Ltd. as technical sales manager. He is a graduate of the College of Aeronautical Engineering, England.

Petrasek becomes sales manager of ground communications equipment. He comes to Collins Canada from the company's Texas division where he specialized in microwave sales. Previous to his association with Collins he spent seven years with the General Electric Co. at Syracuse and New York City. He has 17 years' experience in the electronics and communications field and is a senior member of the Institute of Radio Engineers.

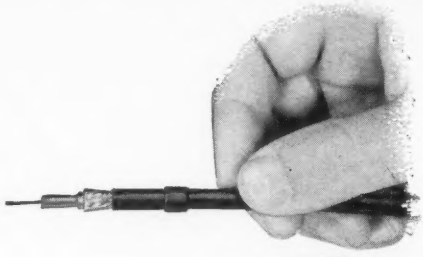
Edge is appointed to the general communications sales department, specializing in microwave and scatter systems. A graduate from the University of Toronto, he has worked as a design engineer with Canadian General Electric.

coaxial and shielded cable grounding

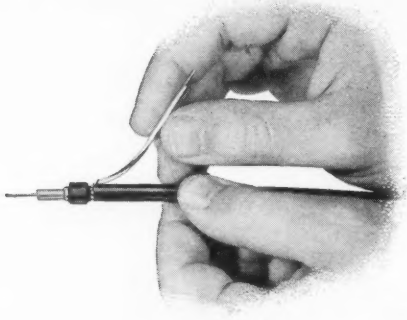
completed in 90 seconds with

HYRINGS

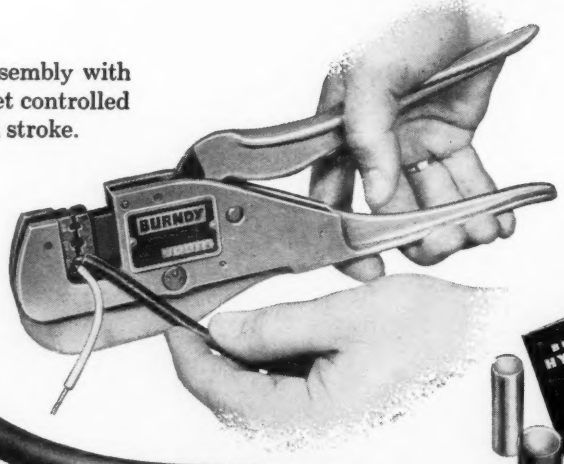
STRIP shield. Slip outer Hyring over insulated conductor. Slide inner Hyring under shield.



INSERT ground lead under outer Hyring and line up over the inner Hyring.



INDENT, assembly with single ratchet controlled compression stroke.



COMPLETED assembly, with Burndy Hylug attached to free end of ground lead.

For details on color-coded BURNDY Hyrings, write for Hyring bulletin.

BURNDY CANADA LTD

381 GREENWOOD AVE., TORONTO 8, ONT.

QUEBEC and MARITIMES: 1434 ST. CATHERINE ST. W., MONTREAL 8, QUE.

REPRESENTED IN:

Winnipeg by NORMAN L. HANEY & CO. LTD.,

Calgary and Vancouver by BUNSTON LTD.

5520

A production part is lowered into a caustic bath so that unnecessary metal can be chemically etched away.

Design Engineering

Machining is done without machinery

Milling is now possible through chemistry. It produces etchings really worth coming up to see

There's a story they like to tell at North American Aviation about one of their engineers who walked into the office of a machine shop owner. Unwrapping an intricate, formed missile part, the engineer, Manuel Sanz, set it on the shop owner's desk.

"Can you make us some of these?" he said.

The intricately curved bends and neatly shaped islands of the part made from one piece of aluminum were carefully checked. After some dubious head shaking came the reply.

"It's impossible. It can't be made." Handing the part back he did a sudden double-take. "Say, how did you make this one?"

This story is eloquent proof that the process by which the part had been made is a very real advance in the art of delicate machining. Sanz's process (for it was he who had invented it) is now gaining recognition. It carries out tricky machining jobs without machinery, using instead a chemical process.

Several years ago North American ran into a tough problem—heliarc welding a formed experimental part. Stress tests on attempted welds showed them to be weaker than the material. For more strength a design change was ordered calling for greater thickness of material in areas to be welded. This made it necessary to remove metal from all other parts of the sheet.

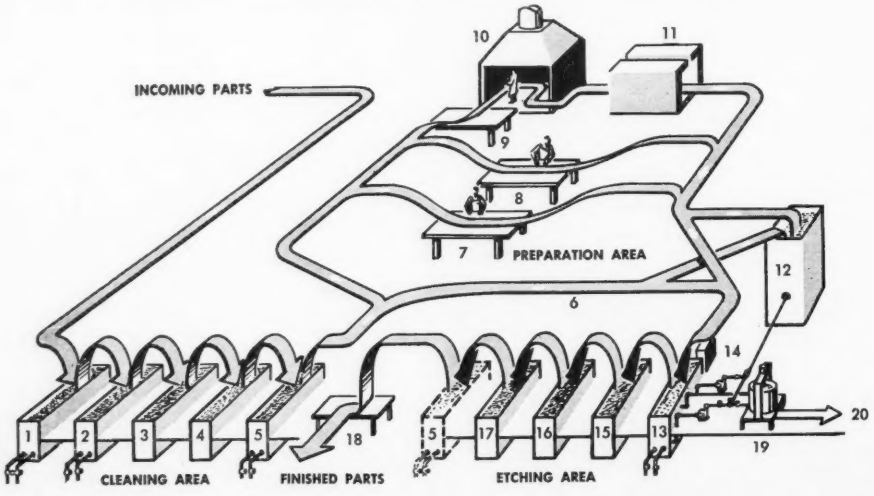
How could this done?

If sheets were formed first, they couldn't be machined. If machined first, they couldn't be formed. It was then that Sanz came up with his jackpot idea. Perhaps the formed sheets could be machined without machines.

He tried out his idea in tanks in the Downey plant salvage area. Taping the edges of a formed sheet, the part was dipped in caustic so that exposed portions could be etched down to the proper thickness. This was the birth of the Chem-Mill process. Sanz envisioned the process making

In the Chem-Mill process the areas to be milled are left bare, other areas covered with a protective coating.

This diagram shows the typical steps necessary to the chem-milling process.



1. Solvent degreaser 180 deg F
2. Hot alkaline cleaner 180 deg F
3. Cold water rinse
4. Chromic acid
5. Hot water rinse 180 deg F
6. Parts requiring no masking
7. Mechanical masking
8. Tape masking
9. Masking for spray coat
10. Paint booth
11. Drying oven
12. Taper etching tank
13. Etching tank
14. Conrtol panel
15. Cold water rinse
16. Smut removal
17. Masking removal
18. Inspection
19. Centrifuge
20. By-product

all types of lightweight, contoured parts without sacrificing strength. He visualized parts being taped or coated with special paint and placed in etchant tanks in wholesale lots—precision machining in mass production.

The first parts processed by Chem-Mill convinced Downey Materials Research and Process engineers that this was an ideal way to make stronger, lighter and better missile and aircraft parts. The company arranged for funds to sponsor a broader experimental program. While the Missile Development Division concentrated on experiments with caustic elements, the Columbus Division worked to improve the acid etchants.

North American aircraft engineers recognized the promise of the new process and designed more than 170 parts for the F-100 Super Sabre and aircraft under development specifically to be chem-milled. Hundreds of aluminum, steel and titanium parts for the NAVAHO development program have been milled to close tolerances by chemical etching.

The Downey Patent Office worked out a co-operative arrangement with Turco Products, Inc., of Los Angeles, under which Turco had exclusive right to grant sub-licences.

A good reason why Chem-Mill has caught on is its ability to remove metal economically. The cost of removing aluminum by means of a Chem-Mill facility averages about one quarter that of a comparable machine tool operation. One installation can handle many parts to the milling machine's single unit.

An addition to machine milling, rather than a replacement, the Chem-Mill process produces etchings worth being invited up to see. In one instance an engineer was able to reduce an assembly with twelve individual detailed parts to a single unit—eliminating fabrication, assembly and joining of many small parts.

Patent coverage issued

Not long ago, basic patent coverage for Chem-Mill was issued by the U. S. Patent Office to the company in the name of Manuel C. Sanz, inventor of the process.

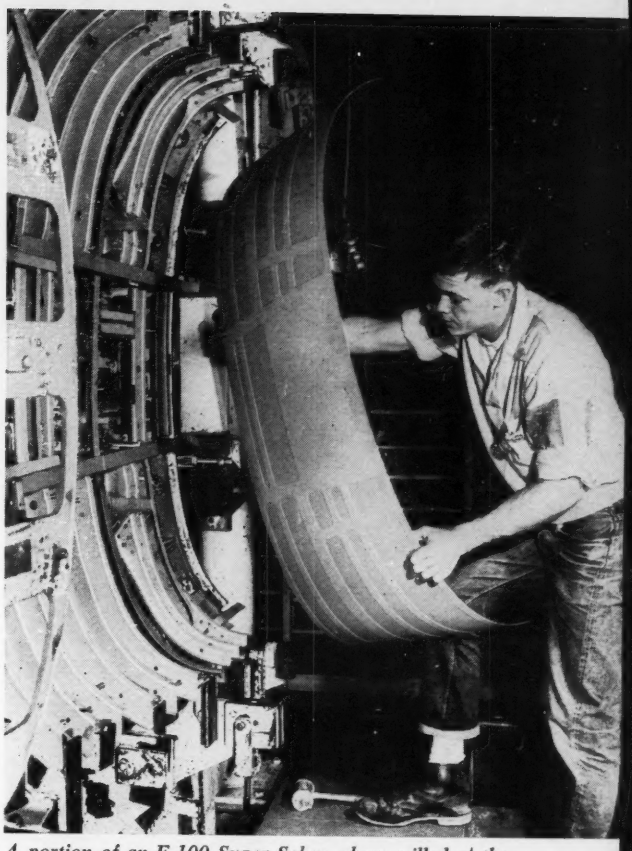
A major portion of the work that Sanz does at North American is devoted to seeing that the seemingly impossible is done in less time than it generally takes to do the possible. Undoubtedly, his most important contribution along these lines is the company's Chem-Mill process.

Basically, his idea is a simple one—it would not be slighting to Sanz to call it elementary—but it took a special type of engineer to prove that the idea would work, sell it to his company and realize its enormous possibilities in development. Luckily, Sanz was just that engineer in the right place at the right time.

He foresaw new design freedom for engineers. No longer would designers be limited in ideas to what could be produced by existing machines.

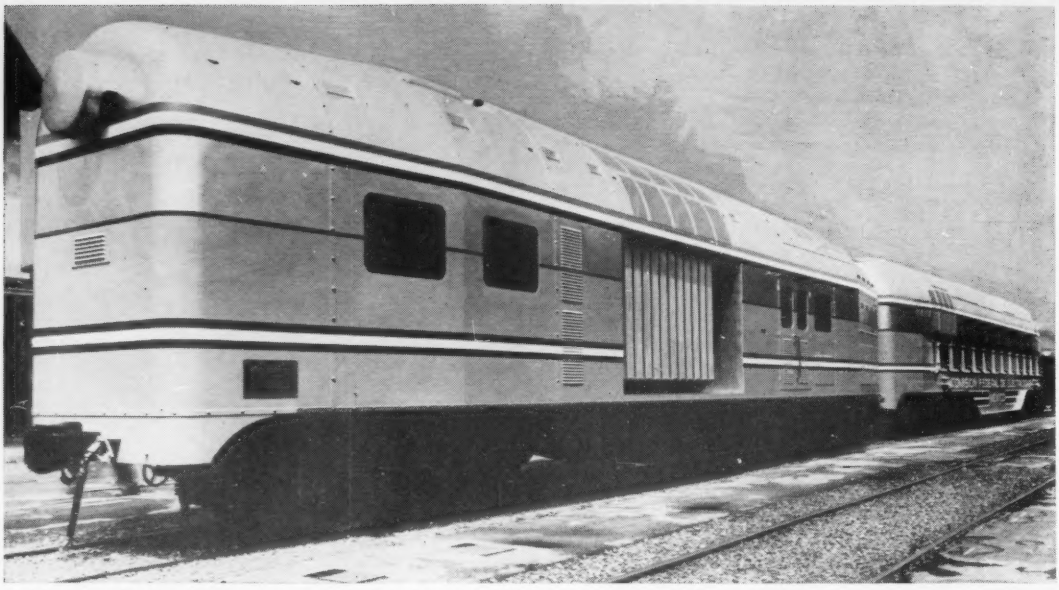
As the pictures on these pages clearly show, the process is highly flexible as far as its end product is concerned.

It would be almost true to say that milling by chemistry has been thought of before and in use for years. In a slightly different form it has been utilized as long as we have known photo-engraving. A line engraving (such as those used in this magazine) is, in effect a chemically milled metal part full of delicate shoulders and hills which will carry the ink to the page. Why didn't someone think of this latest application before? ★



A portion of an F-100 Super Sabre, chem-milled at the Downey, California plant, here being set in its jig.

The intricately fluted part held here forms part of a rocket engine and was made by the chem-milling process.



A Mexican electricity company recently bought this 6,200 kw mobile gas turbine unit which mounts on two rail cars.

The gas turbine can be a moneysaver

The cold Canadian winter is home-sweet-home for the gas turbine. When the mercury takes a plunge the efficiency of this power source climbs

By D. A. G. Kelly, P.Eng. RYERSON INSTITUTE

For a long time now, Canadians have thought of water power and electric power as being synonymous. True, where there is abundant water power there is electric potential but unfortunately sources of cheap water power are fast coming to an end.

Recently, Ontario Hydro built two giant steam stations and is now building a small atomic energy station at Des Joachims on the Ottawa river. Electrical power generated by atomic energy will probably be the main source of power in the future, but despite this, there are many places in Canada that are admirably suited for gas turbine generating stations. An example of this is where there is an abundance of oil and natural gas or where cooling water is difficult to come by in large quantities, as in prairies and tundra deserts. Again, as a mobile source of power for distressed areas, for construction projects or for military purposes, the gas turbine is unsurpassed.

	Gas Turbine (With Preheater)	Diesel Plant	Steam
Operating Cost	0.5444	1.2357	0.5796
Fixed Charges	0.6480	0.8160	0.7050
Total Generating Cost	1.1924	2.0517	1.2846

Table 1 — *Gas turbine economy against steam, diesel.*

Before going further it will be a good plan to consider the construction and operation of a gas turbine. In its simplest form (Fig. 1), it consists of a compressor and a turbine on a single shaft. The compressor sucks in air from the atmosphere at A, compresses it and passes it into the duct work (at B). From there it is passed on to the oil or gas burner where it mixes with a spray of oil or gas and is ignited electrically. As a result of the combustion that takes place in the combustion chamber, large quantities of hot gas are produced. These are passed on to the turbine and cause it to rotate and drive the compressor, generator and exciter, all of which are on the same shaft. The gases from the turbine merely discharge into the atmosphere at C.

To increase the efficiency, the hot gases from the turbine are often passed through a heat exchanger, where the compressed air for the burner receives some of the turbine exhaust heat and so increases the efficiency of the unit. This is shown in Fig. 2.

In the search for increased efficiency, engineers often put two units side-by-side so that the exhaust gas from one unit is often the combustion air for the next. This arrangement, known as a two shaft turbine, can be used with or without a heat exchanger (Fig. 3).

Now, what advantages are to be expected from the

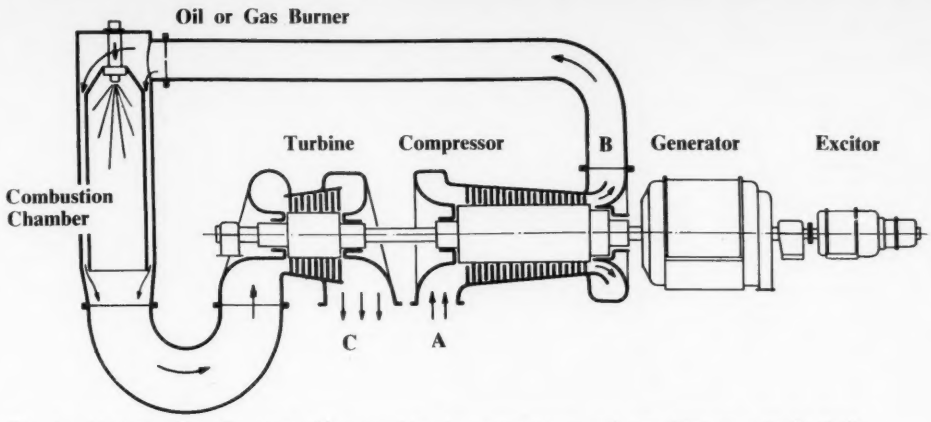


Fig. 1. At its simplest the gas turbine consists of a compressor and a turbine on a single shaft.

Here, in diagrams, is a quick look at how a gas turbine works

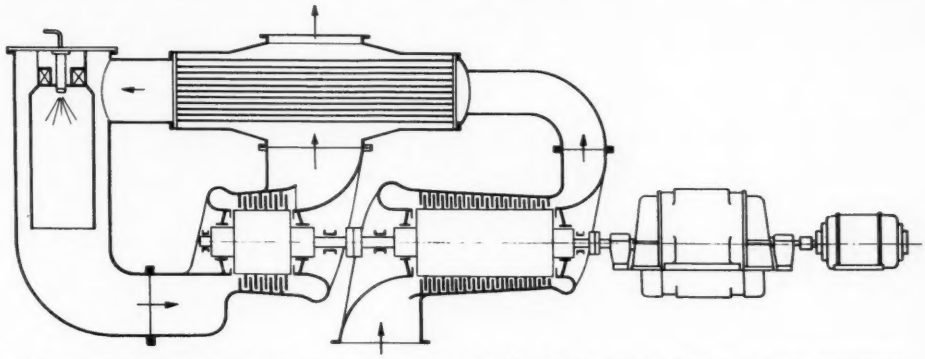


Fig. 2. Increased efficiency results from passing the hot turbine gasses through a heat exchanger.

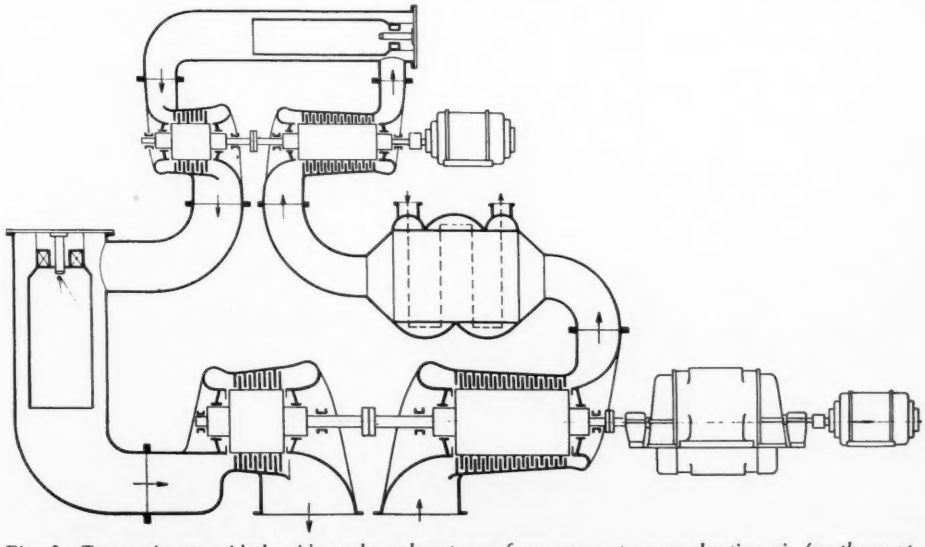


Fig. 3. Two units put side-by-side make exhaust gas from one act as combustion air for the next.

gas turbine as compared with more conventional generating units? Well, in the first place, the prime mover is cheap per unit of power generated. This is obvious when it is realized that the steam station requires coal handling machinery, condensing plant and the like, whilst the gas turbine needs practically no auxiliary equipment. This also makes it very simple to operate and maintain, so that the cost of operation and maintenance can be expected to be much lower than in the equivalent steam station.

Another factor, as far as economy is concerned, is that once the gas turbine is stopped it requires no attendance but can be quickly put into full operating condition again. It is common knowledge that a steam station needs hours, and sometimes days, before it is working at full efficiency after a shut-down. The gas turbine, on the other hand, will work at full efficiency within minutes, so that the amount of fuel wasted during start-up periods is very small.

Finally; for years the diesel engine has been unrivaled as a source of mobile power, but now a 6,000 kw mobile gas turbine power station can be included on two rail cars. This also takes account of the transformers and switch gear associated with the station. A unit of the same output, if made up of diesel generators, would require about six rail cars of the same size. Whilst the efficiency of the diesel engine is slightly greater than that of the gas turbine, the compactness of the gas turbine unit more than compensates for this slight loss.

Although these advantages of the gas turbine are more or less obvious, people are inclined to say: "Well, in the long run, won't the gas turbine be more expensive than other units?" The answer to this question is neither a straight yes or no; the economy of the turbine must be looked into.

Studies have been made by turbine manufacturers on the economy of the gas turbine as compared with steam and diesel plants. The figures for one of these studies are shown in Table 1, the results of which are typical. Estimates are based on a 25,000 kw plant operating for 2,000 hours a year. The comparison is between a single unit gas turbine, a diesel plant and a steam plant and the information given is divided into operating costs and fixed charges. The former include fuel, water, lubricating oil and maintenance; the latter, operating labor and depreciation.

The table of comparative costs indicates that the gas turbine can produce power under these conditions more cheaply than steam and diesel plants and that the diesel plant is quite uneconomical. It should be emphasized, however, that these conditions favor the gas turbine and that, as the operating time per year goes up, the steam station eventually becomes more efficient. These figures show, however, that as a way of handling peak loads, which are not likely to grow into normal loads, the gas turbine is a most suitable machine.

The cheapest fuel in some areas of Canada is natural gas and under these conditions the gas turbine can be more economical than the steam plant, if both are worked continuously. This is because the working temperature inside the turbine can be raised considerably without danger of harmful deposits forming on the blades. Low operating temperatures are a condition which keep down gas turbine efficiency when fuel oil is used.

Canada, with its cold winters, is particularly suited to the gas turbine, for when the temperature falls, and we switch on more electric heaters, the gas turbine feels rejuvenated and its efficiency goes up. This is just what would be expected when it is considered that the efficiency of the turbine depends solely on the difference between the inlet and the exit gases. Actually it has been found that a 10 degree Fahrenheit fall in temperature causes a 7% increase in output.

Up to now, the application of the gas turbine in Canada has been relatively slow, partly because there has been an abundant supply of water power available and partly because the average Canadian is conservative. He likes someone else to do the experimenting, and make the mistakes, but goes ahead with a product that has proved itself. The gas turbine is now reaching the realm of established products. In Europe, gas turbine stations have been operating most successfully for peak load service. In this country, Canadian Utilities Ltd. have installed a 6,000 kw plant at Vermilion and many other orders have now been placed for gas turbine units in Western Canada (see Table 2).

The gas turbine is a most suitable prime mover in the iron and steel industry, where there are normally large quantities of blast furnace gas. These installations are able to replace spare compressors for the steel works and the blast furnace and so reduce the capital cost of the plant. If the gas supply fails at any time, the turbines can immediately be switched to oil.

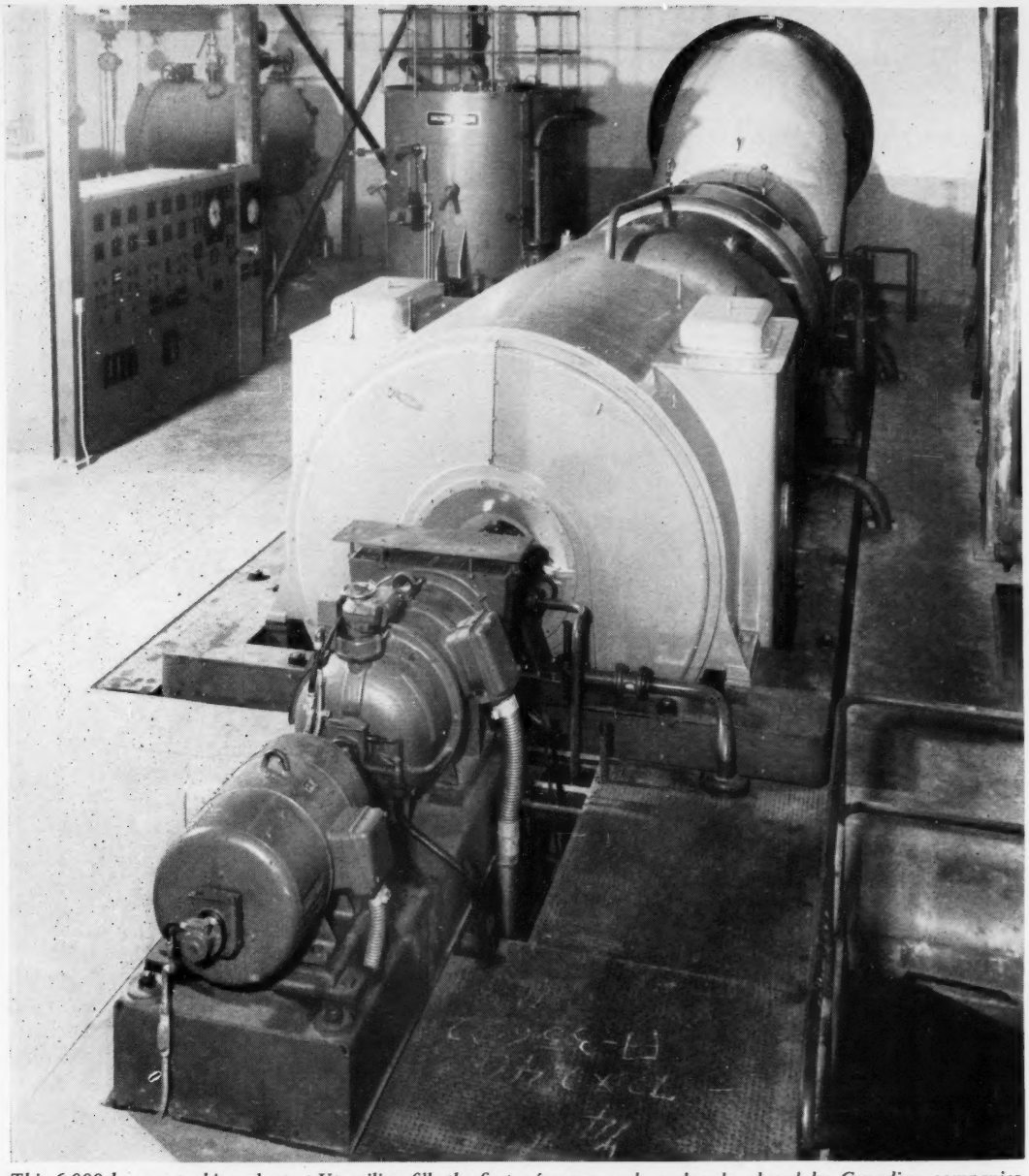
Gas turbines may use gas, diesel oil or bunker C fuel. If the last-mentioned is used, the viscosity of the oil must be reduced by preheaters before it is fed to the nozzles and also, maintenance costs are higher due to undesirable deposits in the bunker C oil.

The cost of maintenance of the gas turbine unit in Canada has been estimated at 0.025 cents per kwh. This includes cleaning of fuel oil tanks, checking of the combustion chamber and fuel injection system, washing of the gas turbine to remove deposits from the blades, soot cleaning and the cooling of the air coolers and the heat exchangers. This price also includes the cost of replacing spare parts that have been damaged in normal operation.

The operating costs of a gas turbine are as low as

Number	Location	Power
1	Vermilion	5900 kw/7680 kw
2	City of Edmonton	20/30000 kw
1	Calgary Power, Joarcam Gas Field	20/30000 kw
3	B. C. Electric, Vancouver	20/25000 kw
1	Western Chemical, Two Hills, Alta.	6200/9000 kw
2	Sask. Power Commission, Kindersley	6200/9000 kw
1	Canadian Utilities, Sturgeon Lake	6200/10000 kw
1	City of Lethbridge	7500/10000 kw
2	B. C. Power Commission, Vancouver Island	19750 kw
2	B. C. Power Commission, Vancouver Island	18000 kw

Table 2 — *Gas turbines in use or ordered in Canada. Source: Brown Boveri and Canadian General Electric.*



This 6,000 kw gas turbine plant at Vermilion fills the first of many orders already placed by Canadian companies.

for any other sort of electrical generating unit. One man can operate a single shaft unit satisfactorily and there is no reason why one of these units cannot be automatically controlled from a remote point by a telemetering system.

The compactness of the gas turbine makes it admirably suited for mobile installations. Recently, the Federal Electricity Company of Mexico bought a mobile gas turbine unit with an output of 6,200 kw mounted on two rail cars. One car carries the gas turbine set, generator, starting motor and control board whilst the other carries a sub-station containing air-blast circuit breakers and a tapped transformer for getting any required voltage. The second car also carries the diesel generating set used for starting purposes.

So far, no commercial gas turbine is fired with solid fuel but many experimental units have been developed both in this country (at McGill University) and in the United States. The difficulties, however, are immense and it will probably be some time before we see coal-burning gas turbines marketed commercially.

In conclusion, it may be stated that the gas turbine is a useful, economical and reliable source of power, making a welcome addition to present generating methods in areas where oil or gas is cheap and where the peak load occurs in cold weather, as it does in the west of Canada. In the east of Canada, where hydro power is still the cheapest, the gas turbine is not an economical base load machine at present, but it might be just the answer for handling future peak loads. ★

Neoprene scores high for versatility

Neoprene can out-perform natural rubber in most applications. Since it was introduced twenty-five years ago, improvements have been many

By J. L. Macdonald DU PONT OF CANADA

Formed by the polymerization of the chemical chloroprene, neoprene has found application in many industries since its first appearance on the market twenty-five years ago. During that time, too, the properties of this man-made substance have been steadily improved. Today it is not just a substitute for natural rubber but a versatile engineering material in its own right, offering a combination of qualities that have broadened the usefulness of resilient parts and opened up new vistas for product design.

Manufacturers of rubber products obtain neoprene either in solid form or as a latex—a water dispersion. Through proper compounding with other ingredients and further processing, a wide variety of finished goods result to give outstanding performance under tough service conditions.

Compositions made from this chemical rubber are resilient, tough and durable. They can be made with the softness of a rubber band or a hardness approaching that of ebonite (the so-called **hard rubber**) and can be moulded to complex shapes to suit any particular design.

Possessing great resistance to abrasion, wear, cutting, chipping and tearing, these compositions are especially noted for their resistance to oils, grease, solvents and many chemicals that ordinarily speed the deterioration of natural rubber. They resist permanent distortion and have excellent air-retaining properties and low permeability to gases and fluids.

They also withstand long exposure to ozone, sunlight and the elements. In addition, neoprene can be compounded to retain much of its flexibility at sub-zero temperatures; at the same time it is resistant to heat. Specially compounded products, while combustible, are flame retardant in that they do not support combustion.

Product designers are naturally interested in the physical characteristics of a material as they affect the finished article's performance and the following is a brief outline of the most pertinent facts about neoprene.

Since, in some cases, the common engineering terms referred to have a new and different meaning when applied to rubber products, the rubber connotation is also indicated.

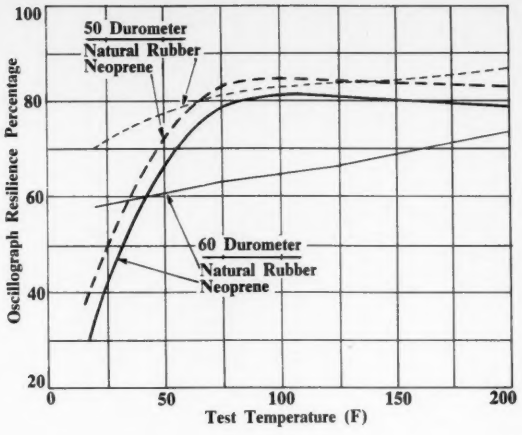
Hardness:

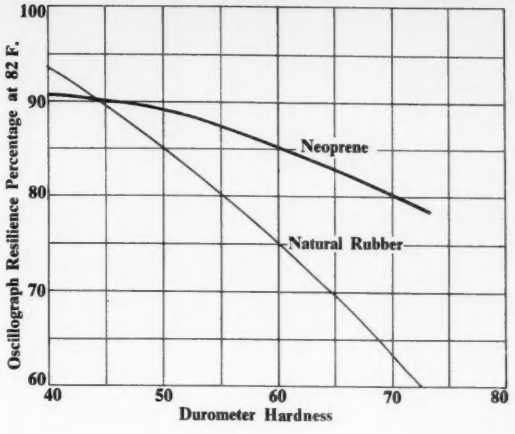
The most commonly used property of resilient materials, hardness, as applied to rubber products, is defined as the relative resistance of the surface to indentation by an indentor of specified dimensions under a specified load. Numerical hardness values represent either depth of penetration or convenient arbitrary units derived from depth of penetration.

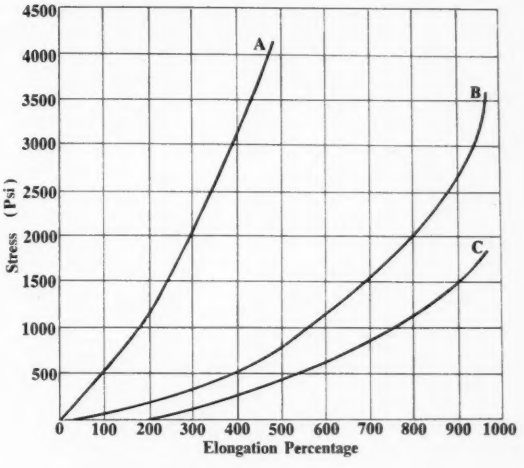
The durometer is the most widely used test instrument for measuring rubber hardness. The device is calibrated in an arbitrary scale from 0 (soft) to 100 (hard).

Most commercial neoprene compositions have a durometer hardness between 30 and 90. It is not possible with neoprene to obtain a hardness of 100. In fact, to reach a hardness much over 90, a large proportion of filler is usually used, often with a sacrifice in other directions. Durometer hardness values below 35 are obtained by the incorporation of plasticizers and extenders like oils, resins or waxes into the neoprene composition. Although of considerable value in specialty goods, vulcanizates containing a large proportion of softeners may be deficient in toughness and strength for some cases, which puts limited use on their applications.

Bent windshield wiper tubing was held in ozone chamber. Synthetic rubber cracked badly, not so neoprene.







Tensile strength and elongation

The tensile strength and elongation of rubber are defined by the American Society for Testing Materials (ASTM) thus: Tensile strength is the force per unit of the original cross-sectional area which is applied at the time of rupture of the specimen. Elongation (or strain) is defined as the extension between bench marks produced by a tensile force applied to a specimen and is expressed as a percentage of the original distance between the marks. Ultimate elongation is the elongation at the moment of rupture. Tensile stress (more commonly called "modulus") is the stress in pounds per square inch of original cross section required to produce a certain elongation. Thus, if a tensile stress of 1,000 psi produces an elongation of 650%, the compound is said to have 650% modulus of 1,000 psi. In rubber, unlike steel, stress and strain in tension are not proportional and the term modulus therefore means different things when applied to the two materials. When applied to steel, modulus is stress divided by strain, a ratio and a constant. Applied to rubber, modulus is the stress at a certain strain, not a ratio and not a constant, but merely the co-ordinates of a point on the stress-strain curve.

The tensile strength of commercial neoprene compositions will vary from about 400 psi to over 4,000 psi. Elongation will vary from less than 200% to more than 1,000%. Stress-strain curves in tension for three typical neoprene compounds are shown and these curves demonstrate both the wide range of tensile properties available with neoprene and the lack of any clear-cut relationship between tensile strength, modulus and ultimate elongation.

Permanent set, stress and strain relaxation

Permanent set is defined as the amount of residual displacement in a rubber part after a distorting load has been removed. Expressed more explicitly, it is the deformation measured at a given time after release from a specified distortion of specified duration, irrespective of whether the load was tension, compression or shear.

In common rubber-industry parlance, however, permanent set is used in place of the more accurate term, **permanent set in tension**, to describe the permanent deformation caused by tension. Values obtained after distortion by compression (permanent set in compression) are called **compression set** and test results on

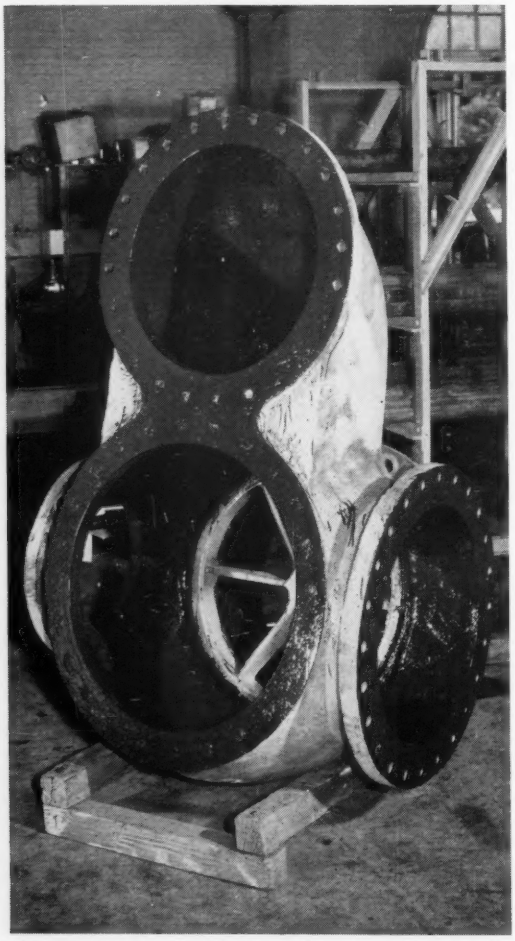
Table 1 — Optimum Electrical Properties

	Neoprene	Natural Rubber
Insulation resistance of 3/64 in cover on No. 12 AWG wire (megohms per 1,000 ft.)	4	4,000
dc resistivity (ohm-cm)	10^{12}	10^{15}
Dielectric strength (v. per mil)	400-600	400-600
Dielectric constant	6.7	2.3
Power factor (%)	2.5	0.5

Table 2 — Relative Permeability of Rubber and Neoprene to Gas at 77 F.

	Hydrogen	Oxygen	Nitrogen	Carbon Dioxide	Methane
Rubber	100	100	100	100	100
Neoprene	26	17	13	19	11

Conveyor belts of neoprene have a reputation for ruggedness. Here hot coke travels a belt in use ten years.



Neoprene coating has been applied to a main sea valve to protect from corrosion, erosion and galvanic attack.

compositions loaded in shear are called **permanent set in shear.**

Neoprene compositions available today are as low (or lower) in permanent set than similar natural or other synthetic rubber compounds. Several years ago, compositions based on the general-purpose neoprene of that day resulted in vulcanizates having somewhat higher permanent set. This shortcoming has been eliminated in the modern general-purpose neoprene; permanent set values from 10 to 15% are readily obtainable.

Similarly, commercial neoprene compositions are the equal of natural rubber in initial creep (strain relaxation) and even lower in long-time creep. Here, too, the older neoprenes behaved differently. Experience with former types showed them to creep much more, initially, than natural rubber. However, they eventually settled down to a lower long-time creep rate and after several months their total displacement was less than that of natural rubber. Now, with the new neoprenes, even this higher initial creep rate can be avoided.

Resilience and heat build-up

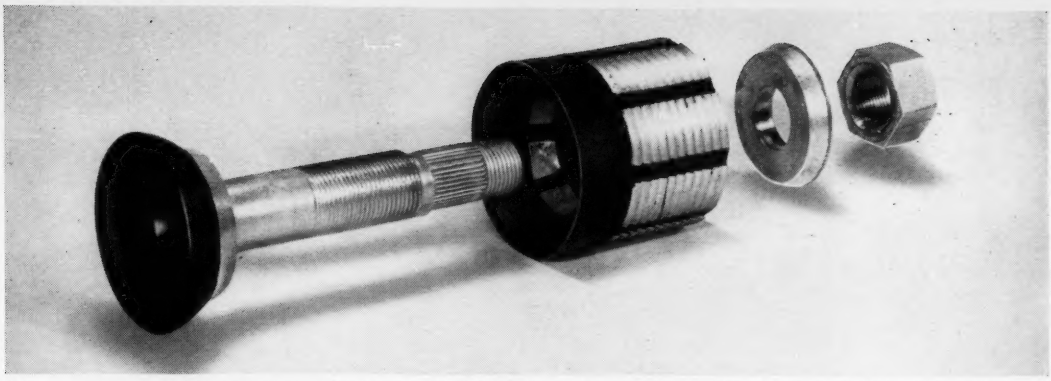
The resilience of rubber subjected to and relieved of stress has been defined by ASTM as the ratio of the energy given up on recovery from deformation to the energy required to produce the deformation. Resilience is usually expressed as a percentage. Hysteresis, the per cent energy lost per cycle of deformation (or 100% minus the resilience percentage) is the result of internal friction and is manifest by the conversion of mechanical energy into heat. Heat build-up, a term peculiar to the rubber industry, is the temperature rise in a rubber body resulting from hysteresis.

The resilience of neoprene, like that of other elastomers, may be varied through a wide range by appropriate compounding. When compounded for high resilience, neoprene compares very favorably with natural rubber, which is generally taken as the standard of excellence in this property. This is evident from the graph which shows the resilience of similar rubber and neoprene compounds over a hardness range. The curves show that "gum" rubber compositions have slightly higher resilience than similar neoprene compounds. However, as the stiffness is increased by adding fillers, the resilience of rubber stocks decreases much more rapidly than does that of neoprene. At a hardness value greater than durometer 45—the hardness range of greatest practical interest — the resilience of neoprene is higher than that of natural rubber.

The resilience of neoprene and natural rubber is compared in the graph showing how resilience varies with temperature. Comparing the two 50 durometer stocks below about 65F, natural rubber is more resilient; above that temperature there is little difference between it and neoprene. Comparing the 60 durometer stocks, the resilience of neoprene is significantly higher at temperatures above 50F.

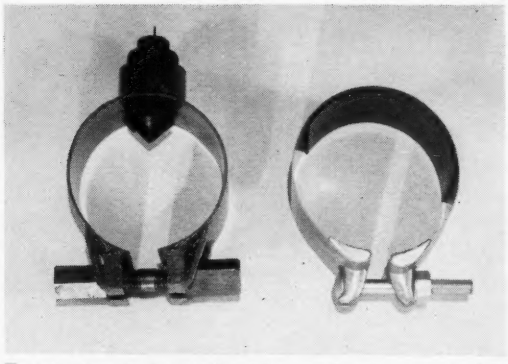
Resistance to abrasion

Abrasion resistance is measured under definite conditions of load and speed and is expressed as a comparison (in percentage) with a standard composition

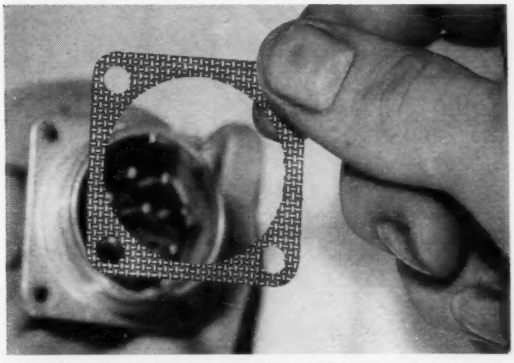


Pipe stopper will hold any pressure the pipe itself will stand, yet it requires no threading or welding. When the nut is tightened the flexible neoprene lip forces against the pipe wall to form an airtight seal. Stopper can be used again.

Resistance to abrasion, chipping and tearing is a valuable property



Two types of pipe-sealing clamp where neoprene does the actual sealing. One at left is for pinhole leaks.



Aluminum and neoprene radio-shielding gasket is effective with high receiver sensitivity and low signal strength.

(Volume loss of the standard/volume loss of the sample x 100).

In most applications and for comparable compounds, neoprene's resistance to abrasion is about the same as that of natural rubber. Field tests of truck tires in off-the-road service, where resistance to cutting and chipping is important, show neoprene treads superior to treads made from natural rubber. And as would be expected, neoprene compositions show a pronounced advantage over those of natural rubber, where abrasion is accompanied by even occasional contact with grease, oil and solvents.

Resistance to flex fatigue

Flex resistance of a resilient material is its ability to withstand fatigue resulting from repeated distortion by bending, extension or compression. Such fatigue may result in several types of failure, the most common being known as "flex cracking" which is the formation of the type of surface cracks found in such products as tires, shoe soles and belting.

Neoprene compositions, observed under many service conditions involving flexing have demonstrated a superiority over natural rubber compounds.

Resistance to tearing

Tear resistance is defined as the force per unit of thickness required (a) to propagate a nick or cut in a direction of the applied stress or (b) to initiate tearing in a direction normal to the direction of the stress. The tear strength of neoprene compositions and those of natural rubber stocks are quite similar. Both elastomers are affected in a similar manner by the amount and kind of compounding ingredients used and by the degree of vulcanization. However, at elevated temperatures, the tear resistance of natural rubber is somewhat greater than that of neoprene.

Electrical properties

Table 1 shows the important electrical properties for neoprene and natural rubber compositions, both compounded for optimum electrical characteristics. The electrical properties of both elastomers can be varied over a wide range by compounding ingredients in the composition.

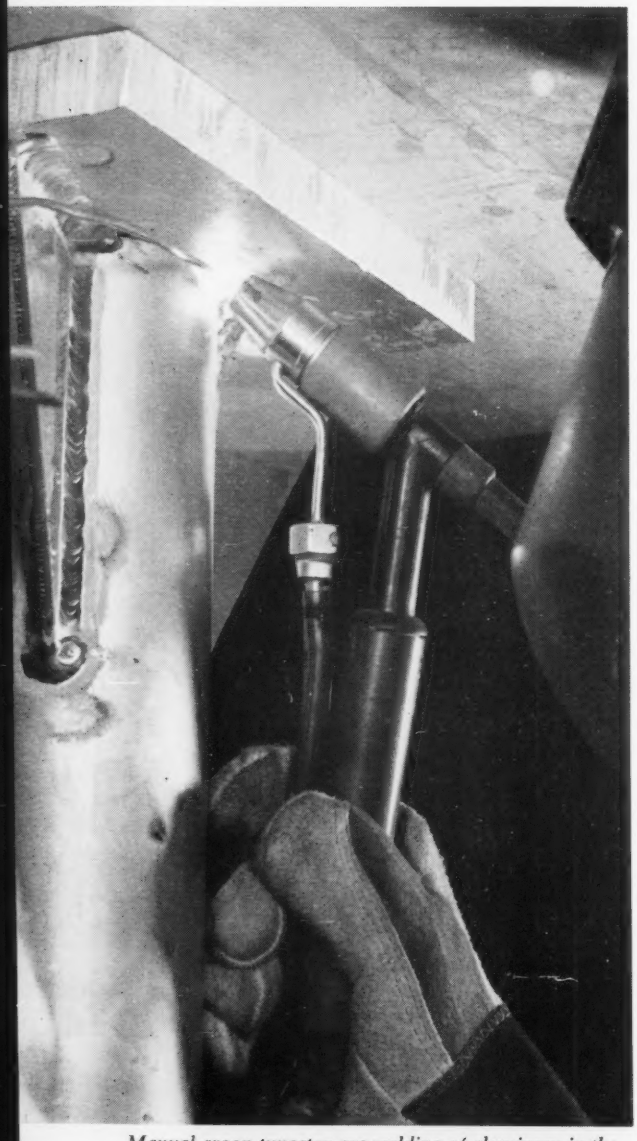
As wire insulation, neoprene has been approved in the U.S.A. for service up to 600 volts and 60 cycles per second. It is used primarily for properties not found in other insulating materials, such, for example, as the neoprene-insulated heating cable requiring heat resistance not found in plastics or natural rubber insulations.

Many articles, like electrical connectors and light sockets, are made from neoprene. Such articles are resistant to attack by ozone and corrosive atmospheres. By

(continued on page 74)

Aluminum welding can be fast at last

Development of the inert-gas-shielded arc processes, namely the argon tungsten and inert metal methods, has lent wings to aluminum welding



Manual argon tungsten arc welding of aluminum in the overhead position—generally considered the trickiest.

By J. F. Whiting ALUMINIUM LABORATORIES LTD.

What does high speed aluminum welding mean to you? It can mean a better product, one giving better service, requiring less material and having lower fabricating and finishing costs. In addition, the appearance of the finished article can be improved greatly by the use of high speed welding.

The high speed welding of aluminum has been made possible by the advent of the inert-gas-shielded arc processes, namely, argon tungsten arc and inert metal arc welding.

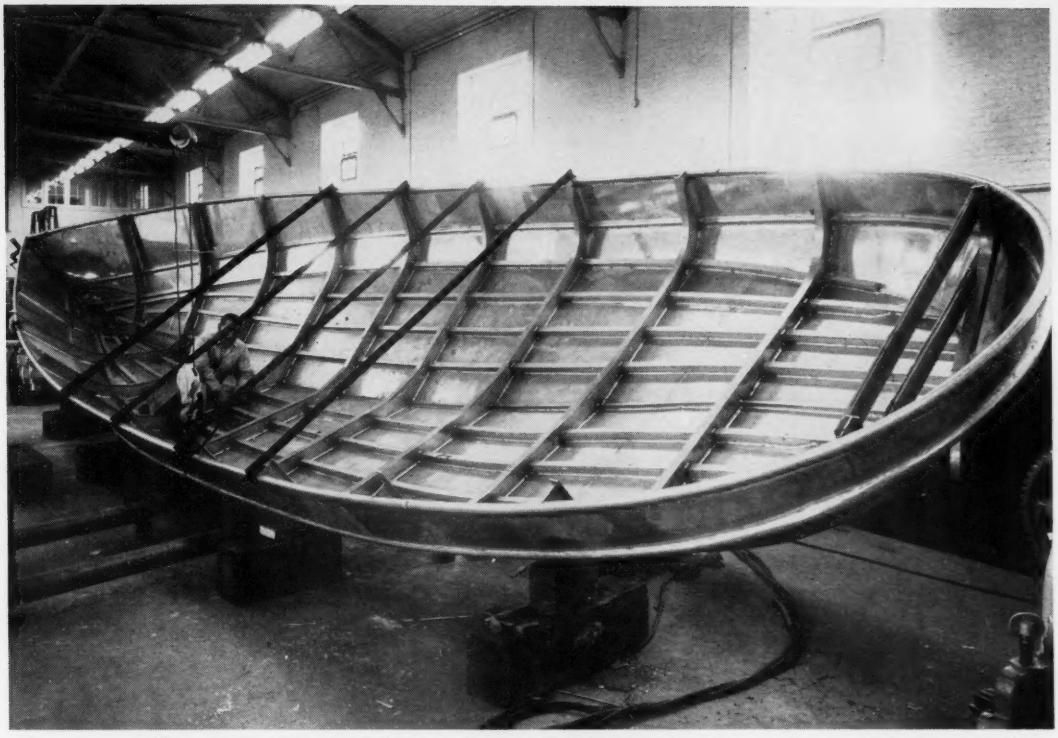
Argon tungsten arc welding was the first of these processes to be developed. It is a process in which an ac electric arc is maintained between the work and a nonconsumable tungsten electrode, in a shield of argon gas. Filler metal is usually added separately. An outstanding feature of the argon tungsten arc process is the complete absence of fluxes. This is possible because, under proper conditions, the arc in argon gas removes the oxide film and the shield of inert gas prevents it from reforming. Argon tungsten arc welding will produce welds of very high quality in all fusion weldable aluminum alloys.

The weldments have a good appearance and require little, if any, finishing. A high production rate is possible with this process because of the high welding speeds attainable. In fact, speeds two or three times those obtained with stick electrode welding of steel are possible.

Excellent penetration is obtained in butt joints which have been suitably prepared. Distortion is usually not a problem with this process, owing primarily to the high welding speed. Since the filler metal is added separately, the operator has the advantage of being able to control the amount of filler added. Standard type bare welding wire is employed. It is lower in cost than flux-coated or specially prepared filler wire and this, combined with the high welding speeds possible, result in low welding costs with this process.

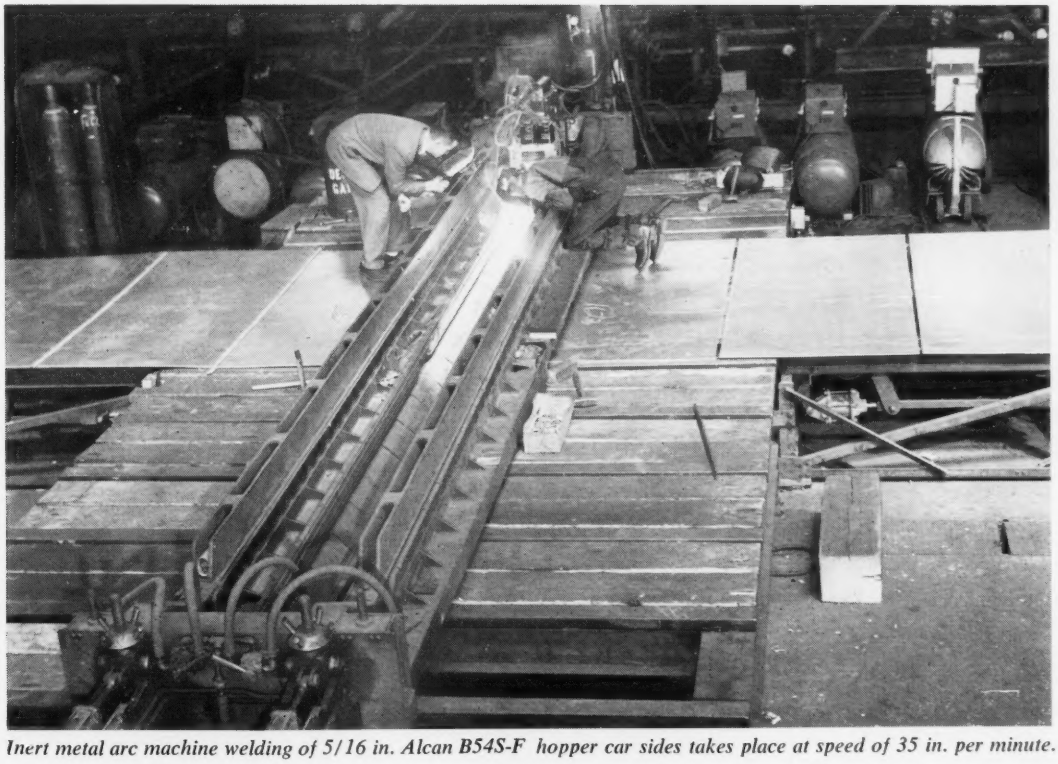
The flow of argon gas must be maintained after the arc is broken until the electrode has cooled below its oxidizing temperature. Automatic control of the duration of the argon gas flow will prevent wastage of gas. Access to the joint by both torch and filler wire must be provided in the design of the weldment. Care and experience are required to obtain full penetration on fillet welds, since there is a tendency to bridge the root unless adequate current and a short arc are maintained.

Argon tungsten arc welding is used principally on



Aluminum workboat designed by Lt.-Col. P. C. King of R.M.C. Kingston, Ont., used extensive high speed welding.

These weldments have good appearance requiring little or no finishing



Inert metal arc machine welding of 5/16 in. Alcan B54S-F hopper car sides takes place at speed of 35 in. per minute.

material from 0.020 to 0.375 in. thick, but thicker material can be welded by this process if the inert metal arc process is not available. The argon tungsten arc welding process is suitable for manual welding in all positions and for machine welding without the addition of filler. Illustrated is the method of manual argon tungsten arc welding in the overhead position. In the welding of aluminum barrels, the joint, of Alcan 55S T-6 sheet, 0.128 in. thick, is under compression during welding and the separate addition of filler is not required. These barrels are welded at a rate of 20 in. per minute. Welded aluminum tubing, however, may be welded at rates up to 40 ft per min, depending on the ability of the equipment to align accurately the edges to be welded.

The inert metal arc process evolved logically from the argon tungsten arc process by replacing the tungsten electrode with a consumable aluminum electrode wire. Inert metal arc welding is a process in which a dc reverse polarity (electrode positive) electric arc is maintained between the work and a consumable aluminum electrode in a shield of argon gas. The electrode wire is fed into the arc and transferred to the puddle to provide filler metal. As with the argon tungsten arc process, no flux is required. X-ray quality welds can be made in all positions at fast welding speeds. High current densities, which result in a concentrated high heat input, are employed in inert metal arc welding. This high heat input results in faster rates of metal deposition, faster weld zone cooling and makes complete penetration easier to obtain than is possible with other arc welding processes. Also, distortion is reduced and the heat-affected zone is narrower than with other welding processes. The inert metal arc process is semi-automatic; only short training periods are necessary before welders can produce high quality welds in all positions. Inert metal arc machine welding is economical, since very fast welding speeds are possible.

Here the operator is welding aluminum in the horizontal position by the manual inert metal arc method.

The equipment for inert metal arc welding is more expensive, requires more careful handling and more frequent maintenance than other arc welding equipment. In production, these limitations are more than offset by the higher welding speeds, wider range of applications, better quality of weld and the absence of flux removal operations. **(Continued on page 78)**

Relative Merit of the Inert Metal Arc and Argon Tungsten Arc Welding Processes

It is often necessary, in the high-speed welding of aluminum, to choose between the inert metal arc and argon tungsten arc processes and this may be a difficult decision to make. The relative merits of the two processes, as set out in the Table, should be used as a guide only, since every circumstance cannot be covered. In production, the inert metal arc process possesses some advantages over the argon tungsten arc process. These advantages are:

(1) Lower welding costs. The welding costs on a foot per hour basis are lower for the inert metal arc than the argon tungsten arc process, owing to the higher welding speed of the former process.

(2) High welding speeds. In many applications, welding speeds several times faster than those obtained by argon tungsten arc welding are possible. The inert metal arc process requires the use of only one hand since the filler is supplied by the consumable electrode. Hence, welding is facilitated.

(3) Less distortion. High-speed welding results in fast chilling of the weld area and hence distortion is much less than with argon tungsten arc welding.

(4) Increased penetration. Deep penetration, especially into the root of fillet welds, is easily obtained with the inert metal arc process, because of the high current density and the concentrated arc.

(5) Higher mechanical properties. The mechanical properties of an inert metal arc weldment are usually higher than those of a weldment made by the argon tungsten arc process owing to the higher welding speed.

(6) Increased corrosion resistance. Less heat effect in the parent metal is obtained with inert metal arc welding than with argon tungsten arc welding and hence the corrosion resistance is better.

TABLE OF RELATIVE RATING

Application Considerations	Relative Rating: Inert Metal Arc Welding	Relative Rating: Argon Tungsten Arc Welding
Economics		
Cost of equipment	2	1
Maintenance of equipment	2	1
Operating factor	1	2
Training time for operators	1	2
Volume of metal deposited	1	2
Welding rate	1	2
Versatility		
Welding of sheet under 0.050 in.	—	1
Welding of material over 0.125 in.	1	2
Welding of Al-Mg alloys	1	1
Position welding	1	2
Use on short irregular welds	2	1
For abrupt changes of contour	2	1
Low speed welding where necessary	2	1
Weld Quality		
Strength	1	2
Ductility of weld	1	1
Corrosion resistance	1	2
Absence of defects	2	1
Penetration	1	2
Distortion	1	2
Machine Welding		
With addition of filler	1	2
Without addition of filler	—	1
Thin gauge butt joints	2	1
Thick gauge butt joints	1	2
Fillet welds	1	2
Welding of Castings		
General reclamation	2	1
Reclamation to specification	2	1
Fabrication with castings	1	2
Repair welding	2	1

Note: Number **1** indicates first choice

Approximating curves with circular arcs

Approximations by circular arcs are easily drawn, dimensioned and machined. Here the author discusses the relative merits of textbook methods

By W. H. Sheppard, P.Eng. AVRO AIRCRAFT

Having had occasion to draw a number of ellipses and being acquainted with several methods of approximating their outlines by circular arcs, it seemed that a thorough investigation into all methods, with a view to finding the best for a particular purpose, might be worth while.

Without going into the relative merits of true and approximate ellipses, it will be realized that approximations by circular arcs are easily drawn, easily dimensioned and easily machined. The question also becomes important in the design of elliptical and other non-circular gears and if the principles of this article are used, the results will be as satisfactory as true pitch lines. These principles can also be extended to the sort of curves met with extensively in aircraft fuselages and fairing lines. A further consideration to bear in mind is that, even if other curves are used, it might be worth while drawing circular arcs to facilitate and expedite tracing.

In investigating all approximations it was found that the complicated constructions and formulas given in reference books by no means gave the best results. However, all are discussed for comparison. The ellipse was considered first, the closest approximation by circular arcs determined and then the principles applied to curves in general. Mathematical calculations are omitted as far as possible, to enable the results to be presented in a concise form.

The ellipse

In approaching the problem, one quadrant only is considered, the major and minor semi-axes being respectively a and b. Then, for any arc drawn at the end of, say, the minor axis a corresponding arc can be drawn to meet it from the major axis. By applying Pythagoras' theorem to triangle OQS (fig. 1) it can be shown that:

$$\text{Radius of large arc } R = \frac{a^2 + b^2 - 2ar}{2(b-r)}$$

$$\text{Radius of small arc } r = \frac{2bR - a^2 - b^2}{2(R-b)}$$

It will be appreciated that for good results the two arcs should meet tangentially, but in published methods this condition is not always met.

Referring again to fig. 1, if Q and S are the centres of the arcs and P their meeting point then the triangles AQP and PSB must be isosceles. The locus of P was investigated and found to be a quadrant arc from B to A, centre at the intersection q of straight lines from C and O at 45 deg to the axes. A satisfactory result can only be obtained with P inside the rectangle and in general the only positions worth considering are those lying between the circles of curvature at A and B of the true ellipse. Fig. 2 shows this portion and also how the centres of these circles are obtained by dropping perpendiculars from the corners of the containing rectangle to its diagonals, the radii being respectively a^2/b and b^2/a.

The angle ϕ = CAP is now considered, whence it can be shown AQP = $\phi' = 2\phi$ and PBO = $45 + \phi$ and PBC = 45 deg. To obtain the closest approximation to a true ellipse, every possibility was considered in turn as follows. In each case Θ is the inclination of the diagonal of the containing rectangle to the major axis.

(a) Let $\phi = \Theta/2$.

In this case AQP = Θ and PQ is perpendicular to the diagonal AB. The result is identical to that commonly obtained in drawing offices by stepping off (a-b) along diagonal AB and bisecting the remainder. Actually greater accuracy can be obtained by stepping (2a—2b) off along the diagonal of the full rectangle. This gives a rather flat-ended ellipse, showing up as an obvious approximation.

In this case

$$R = \frac{1}{2b}\left[(a^2 + b^2) + (a-b)\sqrt{a^2 + b^2}\right]$$

$$r = \frac{1}{2a}\left[(a^2 + b^2) - (a-b)\sqrt{a^2 + b^2}\right]$$

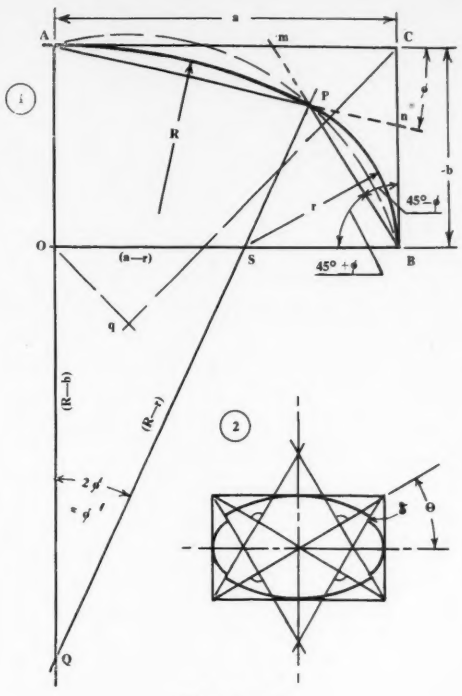
and these formulas are used in various forms in tables of radii. Unless the ellipse is nearly circular, however, better results appear to be obtained by taking $\phi = 2/3\ \Theta$.

(b) Let the arc meet on the diagonal OC of the containing rectangle.

This gives a worse result than (a), but in exceptional circumstances may be useful for inspection doors or pipe flanges if a "square form" of ellipse is required.

In this case $\text{Tan } \phi = \frac{(a-x)b}{ax}$

where $\frac{a^2 + b^2}{a^2} x^2 - \frac{(a-b)^2}{2} x - ab = 0$



Figs. 1 & 2

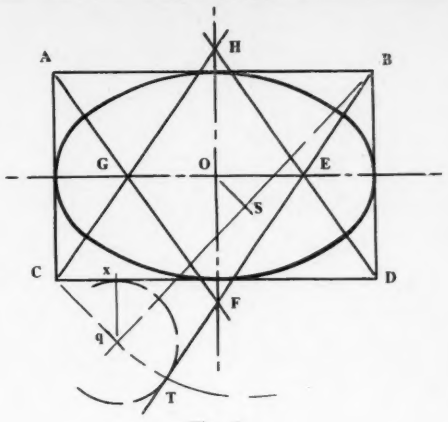


Fig. 3

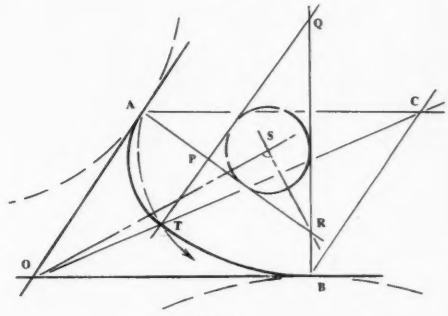


Fig. 4

These geometrical constructions are used for drawing the ellipse and other curves

In this case, the large arc is slightly outside the circle of curvature. For still larger radii the centre tends to become out of immediate reach and in the limit when $\Theta = 0$ results in two semi-circles joined by two straight lines.

(c) Let $\phi = 15$ deg.

This is easily applied since $2\phi = 30$ and $45 + \phi = 60$.

The resulting ellipse has a limiting value of $a/b = 3.75$.

If $\Theta = 30$ (an "isometric" ellipse) it is identical to (a) with the same disadvantages.

(d) Formulas of the type R = ma + nb and r = pa + ab.

A large number of formulas of this type was investigated, exact and approximate, but all were found to correspond to fixed values of ϕ and as such fundamentally unsound. It can be shown that they all correspond to integral values of Pythagoras' theorem and are obtained by substituting integers in 2α, $\alpha^2 - \beta^2$, $\alpha^2 + \beta^2$, and solving for (a-r), (R-b) and (R-r).

A construction given in one popular reference book, involving stepping off (a-b), trisecting and subtracting from b to give r was found to be a special case of the above with $R = \frac{1}{2}$ (5a-3b), $r = 1/3$ (4b-a), Pythagoras' values 8, 15 and 17, $\phi = 28° 4'$. The 3, 4, 5 ratio gives R = (2a-b), $r = \frac{1}{2}$ (3b-a), $\phi = 36° 52'$.

(e) Meetings on perpendicular from C to diagonal AB

This gives good results, the meetings of the arcs dividing the distance δ roughly in proportion to their lengths. Mathematically,

$$\text{Tan } \alpha = \frac{1}{2a^2} \left[-(a^2 + b^2) + \sqrt{a^4 + 6a^2 b^2 + b^4} \right]$$

From this, $\phi = \Theta - \alpha$

(f) Meetings at centre of sides of containing rhombus

This method is largely used in isometric projections when the rhombus consists of two equilateral triangles. The result is flat-ended however, actually in proportion to (a), but a better result can be obtained by continuing the large arcs and then drawing the small arcs to suit on the correct major diameter. In the isometric case the distance of the centre of the small arc from O is practically equal to b. It should be noted that the minor diameter is about 1% of the major diameter oversize for isometrics and less for others.

(g) Miscellaneous

Either of the circles of curvature or any other arc may be drawn first and the other to suit but except in

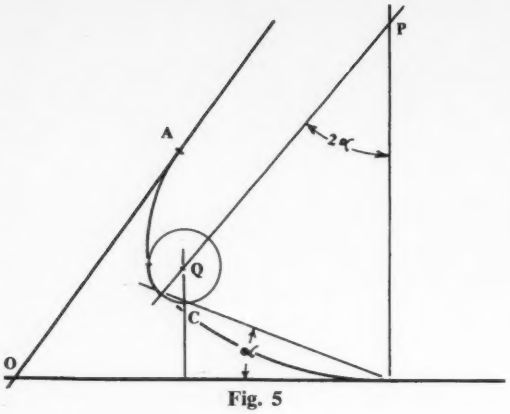


Fig. 5

Circular arcs continued

special circumstances this is not recommended (constructions are discussed later). Sometimes a point on the true ellipse is taken and the arcs drawn to meet there, but except as provided in the next section the meeting is not tangential. It is possible however to draw one arc through one such point and the other to suit, meeting at a different point. Two recognized methods are:

(1) Take the point on the diagonal OC of the containing rectangle (0.816a from O for an isometric ellipse) and draw the large arc through this point and the other to suit. The result is rather flat-ended.

(2) Cross join A (fig. 1) to the middle of CB and C to the middle of OB. Draw the large arc through their intersection and the other to suit. Actually the meeting is near the intersection and the result is good. Textbooks usually give the meetings on the specified points in these cases but the arcs are not then tangential.

(h) Join on true ellipse

Consideration was given to this condition which was found to be most satisfactory in nearly all respects.

Regarding the arcs as cantilevers initially along the circles of curvature of the true ellipse, let each be given a deflection proportional to its length until they meet. As the cantilevers have large initial curvature however, it is difficult to apply exact measurements, but by reasoning that the true ellipse is in fact a line of proportionality between the circles, it might be inferred that the meeting of the arcs should lie thereon. To meet this condition the true ellipse was regarded as an expanded circle and by a long mathematical process it was discovered that the straight lines through the centres of the arcs passed through the corners of the containing rectangle.

Referring to fig. 1 it was found that in this case, when QP passes through C, then m, P and n are equidistant from C. Thus,

$$\frac{\text{Tan } (45-\Theta)}{\text{Tan } \Theta} = \frac{a}{b}$$

This can be solved for ϕ or ϕ' but it is simpler to write as

$$\text{Sin } (45-\phi') = \frac{1}{2}\,\frac{(a-b)}{(a+b)}$$

This can be further simplified as $\text{Sin } 2\phi = \dfrac{4ab}{(a+b)^2}$ but this is not so accurate for interpolation of tables. If required $R = a/\tan \phi$ and $r = b.\tan \phi$

To determine the accuracy of the results, the maximum deviations from the true ellipse was calculated in a radial direction at the centre of the large arc with the following results:

$\Theta = 30$, s = 0.5% of major diameter
$\Theta = 15$, s = 0.8% of major diameter
$\Theta = 5$, s = 1.5% of major diameter

In the isometric case ($\Theta = 30$), the result closely follows the true ellipse.

Geometrical constructions

In dealing with the general problem, it was realized that a quick geometric construction would generally be preferable to formulas or scales and several constructions were evolved from the formulae in (h). A more comprehensive construction was evolved however when it was discovered that all possible lines PQ (fig. 1) were tangential to a circle with centre q and circumference touching OS. Therefore, if one arc is drawn to meet a particular condition, the line PQ can be de-

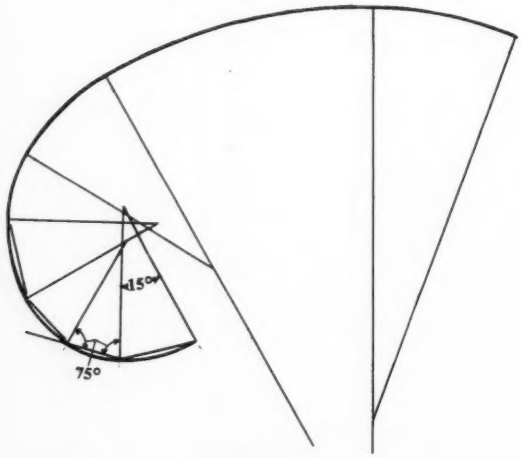
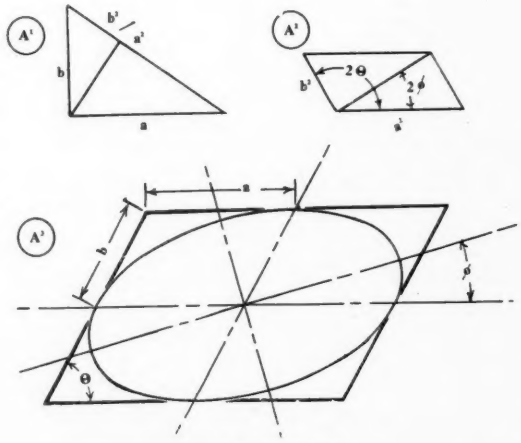


Fig. 6



Figs. A1, A2 & A3

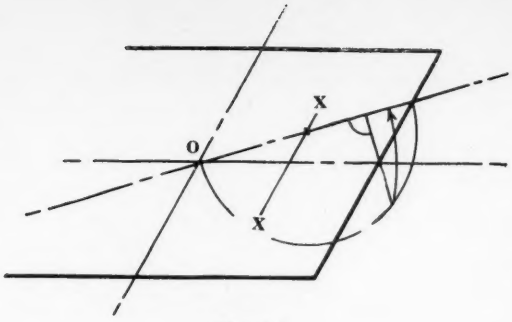


Fig. A4

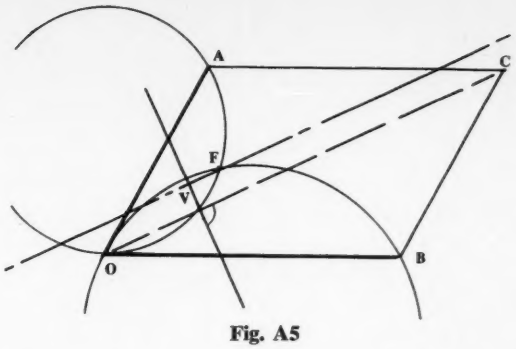


Fig. A5

termined by drawing a straight line through the centre of the arc and touching this circle. For the recommended case (h) however, greater accuracy can be obtained by doubling the size of the circle, proceeding as follows:

(1) Let ABCD (fig. 3) be the containing rectangle of the required ellipse.
(2) Through B and C draw straight lines at 45 deg to the centre lines, intersecting at q.
(3) With centre q and radius qx, draw arc of circle as shown.
(4) Through B draw straight line to touch circle giving centres of arcs at E and F.
(5) Through C draw line parallel to EF giving centres G and H.
(6) Join DH and AF.

For strict accuracy, x should be determined by dropping a perpendicular from q. Also, to locate the point of tangency T, part of a semi-circle should be drawn on Bq, its centre S being on a straight line from O at 45 deg to the axes.

Alternatively to (5) and (6), an adjustable set square can be set through B, touching the circle and used to draw the other lines.

Isometric ellipses

An important case arises when $a/b = \sqrt{3} = 1.732$, as used in isometric projections. The following special construction was investigated but found to give results identical to (a):

Draw a circle on the major diameter and lines at 60 deg thereto through intersections with both axes, appropriate intersections giving centres of arcs and meeting points (w method). The same result can be obtained by lines at 45 deg at the ends of the major axis and thence at 30 deg to the minor, but by substituting 42° and 34° 5′ respectively, results identical to (h) can be obtained.

To enable a comparison to be carried out, the angle ϕ was calculated for each case of isometric ellipse as follows:

Join on diagonal	24°	18′
Large arc equal to circle of curvature	25°	15′
$\phi = \frac{1}{2}\,\Theta$	29°	3′
Large arc passing through cross join	33°	3′
Join on true ellipse	34°	5′
Meeting on perpendicular from corner to diagonal	35°	42′
Meeting at centre of sides of containing rhombus (value corresponding to (h) = 34° 45′)	36°	12′
Small arc equal to circle of curvature	40°	12′

Graphical layout for $\Theta = 15$ gave comparable results.

Non-ellipses

In pursuing the investigation it was gratifying to find that the principle used in (h) could be extended for approximating other curves. Referring to Fig 4, let it be required to join the two points A and B as for example in the root-end fairings of aircraft mainplanes. Conic sections are usually used and in the absence of any controlling feature the parabola is most convenient. To join the two points by two circular arcs however,

(1) Draw tangents to A and B, intersecting at O.
(2) Draw normals at A and B, intersecting at R.
(3) Bisect angles at O and R, bisectors intersecting perpendicularly at S.
(4) With centre S draw circle to touch normals.
(5) Draw a tangent to the circle, intersecting the normals at P and Q, the required centres of arcs.

This line may be drawn through O in conformity with (h) but the results are not so good. If P is taken on the centre line of the true curve (e.g. ellipse or parabola as found in Appendix I or II) the meeting T comes practically on the true curve but for this condition to be obtained exactly the curve must first be drawn in by geometric construction. In general, however, good results can be obtained by taking T on the diagonal of the parallelogram AOBC by drawing the arc AT with centre S as shown in the figure.

It frequently happens that a curve must pass through a control point or touch a circle of clearance. In the latter case arcs from A and B may be drawn to touch this circle as shown in fig. 5. In some cases it may be desirable to increase the size of this circle, conveniently keeping its centre on a straight line through O and the original centre. In the other case, one arc may be drawn through the control point or it may be found preferable to draw a circle through the point and then arcs from A and B to touch it.

In drawing a circle or arc to touch a straight line at a given point and also a given circle, geometry text book methods are correct in theory but liable to inaccuracy if the given circle is small, as this entails drawing a straight line through two points close together. The following improved method has been evolved when it is required to draw an arc to touch a straight line at B (fig. 5) and also a circle with centre Q.

(1) Drop a perpendicular from Q to the straight line intersecting the circle at C.
(2) Draw a straight line through B and C making angle α with the given line.
(3) Through Q draw a straight line at angle 2α to the perpendicular at B intersecting it at P, the centre of the required arc.

Other applications

To draw approximations to curves through particular points, it is first necessary to determine the tangents at these points and standard text-book methods

The principles can apply to aircraft fuselage curves and fairing lines

can be employed. A few more important examples are given.

Parabola

To draw a tangent to the parabola $y^2 = ax$ at the point P, join P to the centre of the ordinate through the origin, having equal height to P. This construction can also be used for drawing a parabola in a rectangle with one side as axis. This must not be confused with the case of drawing a parabola in a rectangle, tangential to both sides at the corners when the centre line is at an angle to the side.

Hyperbola

To draw a tangent through a point P for a hyperbola with asymptotic axes, draw a line through P parallel to the diagonal of the rectangle or parallelogram formed by the co-ordinates of P. Other points can be found by interchanging these co-ordinates and also, at the vertex, by taking their geometric mean. Three arcs can then be drawn to approximate the curve.

Sinusoidals

For the curve $y = a\sin x/b$, the slope at the origin is a/b. Six arcs can be used for each cycle.

Aerofoils and fuselages

Large members may be treated in sections, joining each pair of stations by arcs as above. Alternatively, the circles of curvature can be drawn at each station and each pair joined by their geometric mean. In the latter case, for a limited number of stations it may be possible to have the number of arcs by swinging the circles of curvature until they meet each other but then the tangents at the stations are not colinear with those of the true curve. Alternatively, aerofoils may be treated as continuous curves as discussed later.

Involutes

The complete involute of a circle is a spiral and this is often approximated by drawing the involute to a short finite straight line as a series of semi-circles. Closer approximations can be drawn by the involute of a square, regular hexagon and so on. This is not in line with the present article but the question of using involutes as a basis of approximation was investigated but found to have no advantage. If a regular polygon is used as a basis for the involute, it is impossible to fit the arcs to a particular curve. On the other hand, any pattern of continuous arcs may be regarded as the involute of an appropriate general polygon. An important case arises in the drawing of gear teeth. The best results are obtained by taking the centre of each arc on a tangent to the base circle from the root and arranging the arc to pass through the tip of the correct tooth form. Good results can usually be obtained, however, by taking the centres of the arcs on a circle midway between the base and pitch circles. For large illustrations of single teeth it may be found preferable to draw one arc from the base to the pitch circle and another therefrom to the tip.

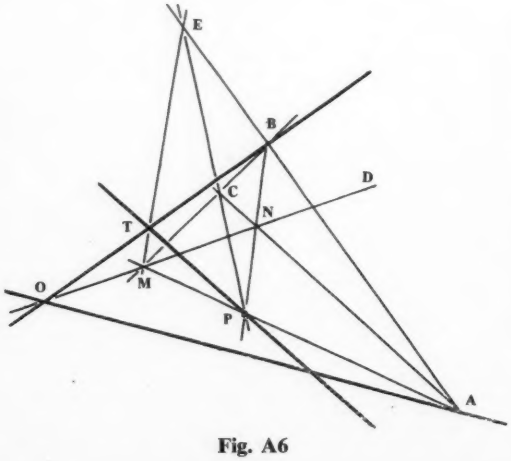


Fig. A6

Closer approximations

It should be clearly understood that the purpose of the foregoing investigation was to determine the closest approximations to the curves with a minimum number of arcs, and not to follow the actual curves. The question of increasing the number of arcs to obtain closer approximations was considered however, as follows.

Eight-arc ellipse

Although the four-arc ellipse is usually satisfactory for engineering drawings, in other cases such as art and illustrative work it may be desirable to increase the number to eight.

Text books usually suggest drawing the circles of curvature at the ends of the arcs and joining by their geometric mean, but this merely over-corrects a large error.

A better method is as follows:

(1) Draw the circles of curvature at each end of the axes.
(2) Draw arcs as for the 4-arc ellipse, recommended method (h).
(3) Draw arcs between those of (1) and (2) equal to their *arithmetic* mean.
(4) Join these by circular arcs equal to the *geometric* mean of each pair. (Actually this is practically equal to the geometric mean of a and b.)

By plotting a range of ellipses it was found that the connecting arcs practically passed through the 4-arc meeting point and also the control point (see Appendix) and that the meeting points were practically on the true ellipse.

Parabola fairing

In problems akin to root-end fairings, if it is desired to follow the true curve, the following procedure should be adopted:

(1) Determine the axis and vertex of the true curve. (Appendix II)
(2) Reflect the end of the shorter limb about the axis, giving a point and tangent on the true curve, dividing it in all into three parts.
(3) Draw in each part by two circular arcs, each pair meeting on the diagonal of the containing parallelogram, which for those at the vertex is parallel to the axis. Since the arc at the vertex follows through, there will be 5 in all. **(continued on page 80)**

Market survey

Canada's ball & roller bearing market

This survey, which was conducted specially for Design Engineering, puts the facts about Canada's ball and roller bearing market at your fingertips

In the ten years since World War II was brought to an end the Canadian industrial economy has forsaken the trot in favor of a full gallop. One group that has matched this extraordinary acceleration stride for stride is the ball and roller bearing industry which has almost tripled since 1946. Consumption of these bearings in Canada has risen from $8 million in that year to an estimated $23 million in 1955 (see graph).

Although Canadian **production** of ball and roller bearings has increased almost ten-fold since 1946, it still accounts for only 35% of the total consumption. Of total imports, the United States supplies about 80% which in turn represents 51.3% of the Canadian demand. In 1946, import from the U. S. rose to $6 million or 74% of the total consumption; in 1955 the figure had increased to almost $12 million, but the percentage had gone down to 51.3%.

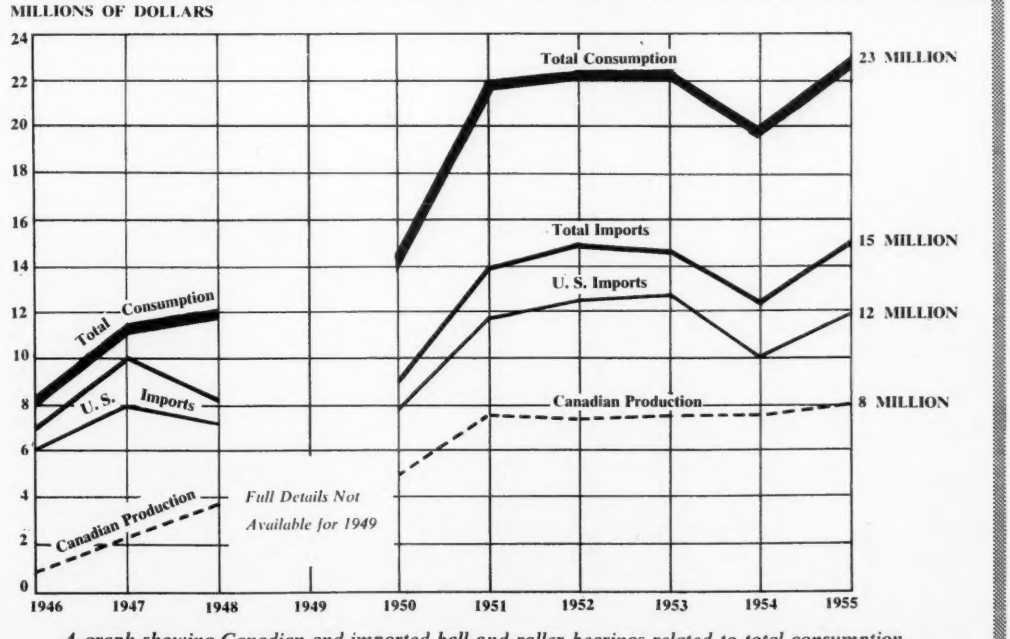
Enquiry among ball and roller bearing companies in Canada indicated that, while they produce bearings of a wide variety, they do not produce any of a miniature calibre. In fact, only one of these companies did produce this type of bearing and they were of the opinion that most come from the U. S. and Europe.

In the past, the major market suppliers actually manufactured their products in the United States or Europe and supplied the Canadian market through either wholly or partly owned subsidiaries. Since the war, however, the trend is to move the manufacturing process to Canada itself and more easily supply the growing demand.

While there are no specific data available as to who are the major consumers of ball and roller bearings, the market must cover many fields in the manufacture of industrial and consumer goods, precision instrumentation, automation, etc., as well as over the counter sales to the general public. The automotive industry could be considered to be one of the major users.

Because of the primary importance of ball and roller bearings to the continued growth of industry in Canada, it seems reasonable to assume that this basic commodity will experience continued, if not accelerated, demand in the future, being in effect the wheels within wheels of our industrial society.

Turn page for table of Canadian imports ▶



A graph showing Canadian and imported ball and roller bearings related to total consumption.

TABLE OF CANADIAN IMPORTS — BALL AND ROLLER BEARINGS 1946-1955

Year		Ball Bearings & Parts	Balls & Rollers (steel) for use in Ball & Roller Bearings	Roller Bearings & Parts	Balls (steel) Not Larger than 3/8" diameter known as Burnishing Balls	Annular Ball and Roller Bearings for Auto & Units Manufacturing	TOTAL
1955	Total Imports	$5,465,145	$700,406	$5,871,392	$20,248	$2,920,637	**$14,977,828**
	Imports from U. S. A.	4,156,317	570,667	4,217,414	15,961	2,833,102	**11,793,461**
	% USA of Total Imports						**78.7%**
1954	Total Imports	$4,770,777	$416,692	$4,381,499	$19,994	$2,604,186	**$12,193,148**
	Imports from U. S. A.	3,588,449	333,031	3,439,529	14,995	2,540,475	**9,916,479**
	% USA of Total Imports						**81.3%**
1953	Total Imports	$5,162,694	$463,260	$5,217,912	$15,429	$3,815,852	**$14,674,947**
	Imports from U. S. A.	3,969,646	399,975	4,395,513	14,429	3,787,055	**12,566,618**
	% USA of Total Imports						**85.6%**
1952	Total Imports	$5,335,729	$228,970	$5,591,646	$ 7,965	$3,620,209	**$14,784,519**
	Imports from U. S. A.	3,761,001	163,321	4,826,270	7,965	3,598,241	**12,356,798**
	% USA of Total Imports						**83.6%**
1951	Total Imports	$5,924,855	$163,656	$4,437,923	$13,450	$3,499,604	**$14,039,488**
	Imports from U. S. A.	4,067,388	124,106	3,831,393	13,450	3,467,735	**11,504,132**
	% USA of Total Imports						**81.9%**
1950	Total Imports	$3,366,442	$137,811	$2,435,288	$ 8,196	$3,146,064	**$ 9,093,801**
	Imports from U. S. A.	2,507,418	100,394	2,116,334	8,196	3,074,684	**7,807,026**
	% USA of Total Imports						**85.8%**
1949	Total Imports	$2,868,676	$ 97,642	$2,422,991	$ 7,251	$2,320,009	**$ 7,716,569**
	Imports from U. S. A.	2,125,378	94,191	2,192,098	7,251	2,320,009	**6,738,927**
	% USA of Total Imports						**87.3%**
1948	Total Imports	$3,079,590	$115,179	$2,550,811	$13,486	$2,530,811	**$ 8,289,877**
	Imports from U. S. A.	2,415,251	100,627	2,297,814	13,486	2,530,811	**7,355,989**
	% USA of Total Imports						**88.7%**
1947	Total Imports	$3,335,142	$154,434	$2,385,536	$28,385	$3,078,704	**$ 8,982,201**
	Imports from U. S. A.	2,534,560	144,148	2,168,834	28,385	3,078,704	**7,954,631**
	% USA of Total Imports						**85.6%**
1946	Total Imports	$2,621,400	$112,623	$2,243,959	$10,470	$2,164,623	**$ 7,153,075**
	Imports from U. S. A.	1,747,029	89,461	1,913,485	10,470	2,156,188	**5,916,633**
	% USA of Total Imports						**82.7%**

The Army gets a new shooting iron

End of a world-wide search for a new rifle to arm the Canadian soldier is the FN-C1, modified Belgian weapon

Canadian troops tested the FN prototype exhaustively.

When the Canadian Army last year decided to adopt the new semi-automatic FN 7.62 mm (.30 calibre) rifle as the Canadian forces standard, it was more than a national or Commonwealth decision.

Earlier, in 1953, Canada, Belgium, France, the United Kingdom and the United States announced the adoption of a standard small arms round. The FN rifle ended a search for an improved weapon to fire the new ammunition.

The new weapon is called the FN-C1, a modification of the Belgian FN (Fabrique Nationale) rifle. It has been adopted as the standard infantry weapon by Britain, Canada, Belgium and Australia.

The new rifle will replace the various models of the .303 Lee-Enfield, used by Canadian soldiers since the days of the First World War, 1914-18.

Extensive troop trials with the FN prototype were carried out last year by infantry battalions and other units in Canada, the sub-Arctic and Germany. These tests proved the new weapon's ability to provide a high standard of performance under all weather conditions.

Soldiers engaged in the trials expressed confidence in the new weapon. It handles easily, has a good "feel" for the infantryman and less recoil than the rifles formerly used. In most cases, soldiers have shown an ability to improve their marksmanship when using the FN rifle.

The FN rifle is gas-operated and air-cooled, and is capable of a high rate of accurate semi-automatic fire.

Located on the left-hand side is the lever which selects safety or semi-automatic fire, and also the cocking handle, which does not move when the rifle is being fired. Placement of the gas cylinder on the top of the barrel reduces the tendency of the weapon to lift when fired.

A separate pistol grip is located behind the trigger guard and a carrying handle pivots upward over the barrel. The weapon is fitted with a 20-round box magazine, inserted from the bottom.

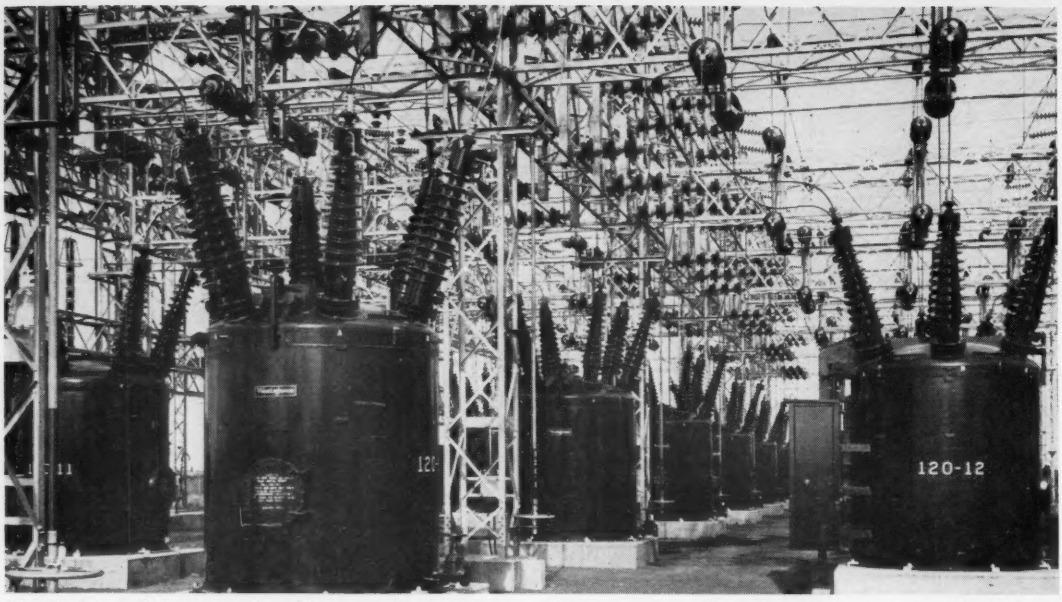
Field stripping is described as "amazingly simple." Press a catch on the left-hand side forward of the butt, hinge up the barrel as you would "break" a shotgun, and slide the working parts out to the rear. The main recoil spring remains housed in the butt and need not be taken out.

The breech block is mechanically locked before firing and is not unlocked until the bullet has left the barrel. When the magazine is empty, the breech block stays open after the last shot has left the rifle. ★

	No. 4 (Enfield) (.303 in.)	FN 7.62 mm (.30 in.)
Dimensions (in.)		
Length	44.5	41.5
" with bayonet	53.0	50.0
" of barrel	25.2	21.0
Sight Radius	28.5	22.0
Magazine Capacity	10 rounds	20 rounds
Weights		
Rifle (bare)	8.81 lb	8.84 lb
Magazine	.40 lb	.53 lb
8 rds ammo.	.45 lb	.41 lb
Total Weight Without bayonet	9.66 lb	9.78 lb

The new FN rifle compared with the outgoing Enfield.

Instruction in grenade firing by rifle from a corporal.



This hydro project shows the wide range of equipment needing protection. Phenolic resins are a usual choice here.

Be careful when you specify coatings

Cutting costs at the protective coating stage can often prove a false economy. Hints from an expert tell what to look for before specifying

By T. G. H. Michael HOWARD & SONS (CANADA)

The coating is a very important part of any manufactured object. It may perform one or more functions. These include protection, to maintain the article in its original condition despite exposure to weathering or wear in service. Another function is to improve the appearance, a factor which may make the difference between the success or failure of the product. The coating may also have a specific functionality, as is the case, for example, with luminous paints or temperature-indicating paints.

The paint chemist has developed a number of materials having many different properties, and he is able to combine these in order to arrive at the desired end result. All too often, however, his formulation is hampered by conditions of cost laid down by the purchaser. This is a very short-sighted action by the buyer. It is generally estimated that the cost of the finish is 10-20% of the total cost of the finishing operation, the balance being the labor necessary to apply it. In view of this, it is surely poor economy to save a few cents on the cost of the paint and very probably lose months or years of service life.

Where cost cannot be disregarded, however, another factor is very often overlooked. This is the covering of the coating. A gallon of finish will cover a certain number of square feet, a number which may vary very much. It should be obvious that the important figure is the cost per square foot of covered surface and not the cost per gallon of liquid paint. It may easily happen that the paint with the highest cost per unit of volume is the cheapest on the basis of cost per unit area of surface covered.

There are four components in most industrial finishes. These are: the **vehicle,** which is the film-forming ingredient; the **pigment,** which imparts the color; the **solvent,** which regulates the thickness or viscosity and in large measure the application properties; and **additives,** which are present in small amounts for specific purposes.

Some of these components may be absent in some circumstances. For example, clear finishes contain no pigment and certain types of specialty coatings used in the electrical field may not contain any solvent.

Product finishes are of the air dry or baking type. The selection will depend on the equipment available at the manufacturing plant and on the particular qualities desired in the finish. For the ultimate in hardness, chemical resistance and durability, a baked finish is generally desirable.

Historically, the early industrial or product finishes were based on naturally occurring oils and resins. These were combined to form varnishes, and for a long time (until about 1912) were the basis for all industrial finishes. They had many drawbacks, and since that time many synthetic organic chemical products have been developed for use in industrial finishes. A summary of the more important of these products is given in Table I. They are listed approximately in order of

their development and not in order of importance. All these vehicles are in current use in various types of industrial finish.

Very often more than one vehicle will be used in a finish. Blends of alkyds with urea or melamine resins are common, as are combinations of nitrocellulose and alkyds. In this way, advantage can be taken of the good features of several resins.

As an example of the possible variations which can be encountered in formulating a finish, let us look at nitrocellulose lacquers. The vehicle portion of such a lacquer will typically contain nitrocellulose, a resin and one or more plasticizers. The function of the resin is to introduce hardness and gloss. The purpose of the plasticizer is to render the lacquer flexible and enable it to withstand wide temperature changes without rupture.

Several different grades of nitrocellulose are manufactured for coating use; there may be 200 resins capable of being used and at least 100 plasticizers suitable for lacquer use. This will give some idea of the staggering number of possible combinations.

The choice of pigment depends upon the color required, and to some extent upon the service which the finish will be called upon to withstand. Some pigments, for example, are unstable in the presence of acids, while others bleach or darken when exposed to light. Careful choice of pigment may result in greater durability in a finish.

The solvents used will be determined by several factors. The type of vehicle may make a particular class of solvent necessary. The method of application (spray, brush, dip, and so on) will affect the solvent choice, as will the speed and type of drying necessary. The paint chemist has at his disposal solvents capable of dissolving any of the resins used as vehicles. He can also choose and blend solvents to produce any desired rate of drying within reason.

The additives mentioned are a group of substances necessary for special effects. For example, oil varnishes and alkyd resins require driers in order that the coating may dry in a usable length of time. These driers are metal salts of organic acids, the metals most commonly employed being lead, cobalt and manganese. Other additives may be used to retard mildew, prevent settling and improve flow. ★

SURVEY OF SYNTHETIC PROTECTIVE COATING VEHICLES

Type	Approximate date of introduction	Composition	Outstanding Properties	Weaknesses	Important Uses
Phenolics	1912	phenol-formaldehyde condensation products	Low cost, durability	dark color, poor color rentention	
Nitrocellulose		nitrated cotton	Rapid dry, good durability	expensive solvents required, many coats required	furniture finishes
Alkyds	1930	vegetable oil modified condensation products of polyhydric alcohols and polybasic acids	Versatility, durability	low alkali resistance	come close to general purpose vehicles
Urea resins	1933	urea-formaldehyde condensation products	Pale color, hardness	require baking	refrigerator, auto enamels
Melamine	1935	melamine - formaldehyde condensation products.	Pale color, hardnes	require baking, expensive	appliance & auto enamels
Vinyl	1938	poly(vinylchloride-acetate)	chemical resistance	require strong solvents or high temperature	marine primers
Epoxy resins	1950	modified bisphenol-epichlorhydrin condensation products	alkali resistance, adhesion	high cost	washing machine enamels
Silicones	1950	(modified) polysilanes	alkali resistance, heat resistance, high dielectric strength	extremely high cost	maintenance enamels for high temperature exposure. Electrical insulating enamels
Polyesters	1952	condensation products of dihydric alcohol and dibasic acids			

New products & materials

New items which can help you on the job

Ultra-violet lamp

A multi-purpose, long wave ultra-violet radiation source for chromatography, laboratory research, inspection and medical observation has just been put on the market by **Black Light Corporation of America.**

Called the Blak-Ray model B-100, this new black light can be used for any method requiring a concentrated source of ultra-violet at 3,660 angstrom units.

The lamp head is attached to the sturdy base through a spring-tension arm which allows the ultra-violet beam to be rotated in a 180 deg arc. A trigger mechanism makes it easy to slip the light source from its base and manoeuvre it by hand with a pistol-grip handle. For mounting over a lab table or in an inspection booth, there is a convenient D-ring on the back of the lamp head.

The light source is a 100-watt long wave, ultra-violet bulb, flood or spot type. A 5in. rounded, heat-resistant, red-purple filter, specially selected to transmit ultra-violet rays, blocks out visible light. Provision for the easy installation of an extra filter to reduce visible light further has been made by the manufacturer.

The spot bulb emits a concentrated beam which will fluoresce an area 15 ft. in diameter from a distance of 30 ft. while the flood bulb will activate an area 30 ft. in diameter from a distance of 30 ft. (200)

• • •

Rack Cooling Fan

Now in production by **McLean Engineering Laboratories,** model 3E40 rack cooling fans for electronic cabinets. The new model fits standard 19 in. racks but occupies a space only 5¼ in. high. It has RETMA notching for ready installation and is complete with filter and 5¼ in. x 19 in. stainless steel grill. No color matching is required. Air delivery is 140 cfm. The motors are placed at an angle so that the unit may be installed for either a downward or upward angle of air discharge. This construction enables the unit to be used where space is at a premium. Modifications are available to customers specification. (201)

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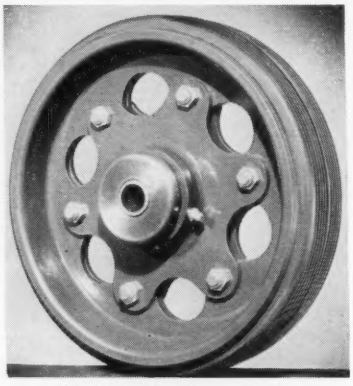
Rubber-tired wheel

A new demountable 10 in. diameter rubber tired wheel that rolls easier, lasts



Easier rolling, longer lasting

longer, saves 63% in cost and whose tire may be replaced easily in 5 minutes has been announced by the **Rapids-Standard Company.**

The new wheel, the Rapistan MB, is an addition to previously announced models in the 6 in. and 8 in. diameter sizes.

This new wheel design is claimed to be ideal for heavy industrial and commercial usage, particularly in tow lines and with trailer and floor trucks.

A steel band, to which the rubber tire is molded, is designed to place the rubber tire under compression when under load, thereby reducing the outward squashing effect prevalent in average molded-on rubber tired wheels. Component forces developed as a result of the concave metal band tend to retain the rubber tread inward to resist spreading. This results in less rubber on the ground under load, and hence less resistance to rolling. (202)

• • •

Pipe welding electrode

A new electrode, the Fleetweld 5-P, suitable for all E-6010 applications, but especially designed for pipe welding is announced by the **Lincoln Electric Company of Canada Ltd.** Pipe welding especially on root passes with a "vertical up" technique at low currents, demands exceptionally smooth arc operation, deep penetration and good bead wash-in. In addition to having these characteristics, the new electrodes also provide minimum slag interference, resulting in quick freezing of the molten metal and less tendency for windows and porosity. The electrode produces a flat-shaped bead in an even deposit from which slag is easily removed.

Fleetweld 5-P can be used for welding pipe, pressure vessels, X-ray applications and other ASME code work. It is suitable also for all-position structural welding, machinery weldments and ship welding. It conforms to AWS E-6010 requirements and has been approved by the American Bureau of Shipping. It is available in ⅛ in. and 5/32 in. diameters. (203)

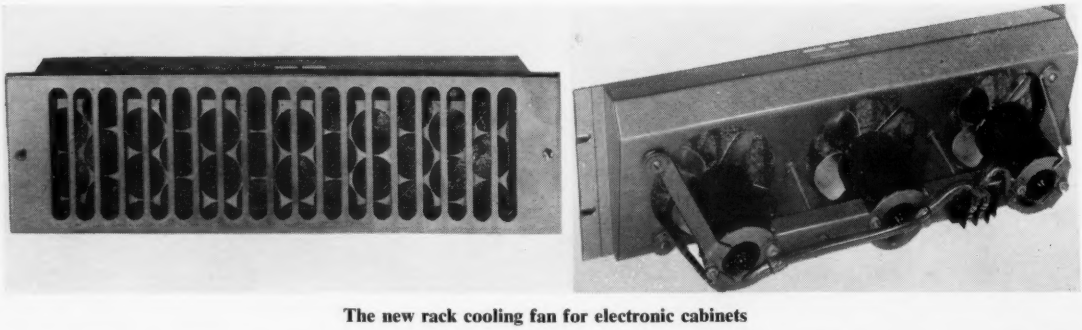
• • •

Silicon diodes

A 1,000-volt silicon diode is one of a series of high voltage silicon diodes now available from **International Rectifier Corporation.** The diode is especially designed for power applications where high ambient temperature, reliability, high efficiency and miniaturization are prime factors.

These high voltage diodes are available in peak inverse voltage classifications of 600 v, 800 v and 1,000 v, with half

(continued on page 62)



The new rack cooling fan for electronic cabinets

MATCHED BELTS ARE IMPORTANT

IMPORTANT
THESE 14 BELTS ARE MATCHED FOR ONE DRIVE!
Do not untie bundle until ready to apply
PRECISION MATCHING
assures longer belt service life, less loss of power, greater all 'round efficiency.
GOODYEAR
MULTI-V BELTS

to assure extra belt life ...equal pull...less slippage

Matching of Multi-V belts is in fact precise length measuring done under working tension —very close limits are maintained. Matching is important because it is your assurance of V-belt sets in which each belt has proven its ability to work with its team-mates longer, without unequal stretch, uneven wear or wasteful slippage. Each belt carries its full share of the load. In addition, matched Multi-V sets will transmit more power per dollar . . . will hold power waste to a minimum.

BELT MATCHING IS MIGHTY IMPORTANT AT GOODYEAR! Each set of Goodyear Multi-V belts is subjected to length inspection on a precision matching machine. Each V-belt must match . . . must measure up to its companions in the set . . . and the set can be identified by the red tag.

THIS RED TAG IS IMPORTANT TO YOU! It signifies the best in Multi-V belts. It is backed by Goodyear's 50 year experience in producing industrial rubber products. Only matched sets of Goodyear Multi-V belts carry this tag.

GOODYEAR MATCHING PAYS OFF! No matter what your multiple V-belt drive problem . . . whether light or belt killing, Goodyear has a Multi-V belt set matched and tagged to deliver all the power you pay for.

GOODYEAR

INDUSTRIAL RUBBER PRODUCTS—ENGINEERED FOR THE JOB

For complete information write or call your nearest Goodyear office at— Moncton, St. John, Quebec City, Montreal, Toronto, London, Windsor, Winnipeg, Regina, Saskatoon, Calgary, Edmonton, Vancouver, or Head Office, New Toronto.

New products *continued*

wave d-c output currents of 125 ma at 75 C ambient temperature. The operating temperature range is from minus 55 C to plus 150 C ambient. The diodes occupy a volume of only 1/16 cu. in. (⅜ in. dia. x 9/16 in. long) and are provided with pigtail leads to facilitate easy wiring into crowded chassis.

To ensure freedom from contamination, these diodes are hermetically sealed and the mechanical construction is designed for excellent stability and reliability. This combination, plus miniaturization, makes them an ideal component for high voltage bias supplies, computing machines, magnetic amplifiers, guided missile circuits, airborne radar and for replacement of vacuum rectifier tubes. (204)

• • •

Micro Switchette

An improved version of the well-known Burgess V3 micro switchette is announced by **Burgess Products Co. Ltd.**

Made to the same general specification and dimensions as the present model,

And now it has nylon

with which it is interchangeable, the improved V3 has a nylon plunger in place of the phenolic resin plunger formerly used.

Nylon offers important advantages over other molding materials for plungers. Life expectation is greater because, being self-lubricating, nylon reduces plunger-to-case friction. Foreign bodies can embed themselves in the plunger rather than jam it or seep past it into the switch mechanism. The switchette as a whole will withstand rougher treatment since the elasticity of the nylon plunger can absorb shock without distortion or abrasion. (205)

• • •

Crystal Oven

A new miniature crystal oven designed for HC-6U holder, less than an ounce in weight, is credited by its manufacturer, **James Knights Company,** with a temperature stability of ±0.25 C at constant ambient temperature and ±0.5 C over an ambient temperature range of —55 to +75 C.

Known as the JKO-10 crystal oven, the new unit has an easily detachable cover, new heater binding tape and low inductance winding.

It is manufactured in a choice of heater voltages from 6.3 V to 48 V, ac or dc for greater flexibility, and has a rapid warm-up time of 7 minutes at —55 C.

The JKO-10 has a seated height of 1.75 in. and a diameter of 0.875 in. It is also available for the HC-13U holder with a seated height of 2.25 in. (206)

• • •

Power Meter

A new power meter, Type HB UHF Variload, has been announced by the **Canadian Westinghouse Company.** It has a terminating resistance adjustable to any value between 40 and 100 ohms, and a direct reading 0-60 watts at either 50 ohms or 75 ohms terminating resistance (93 ohms on request).

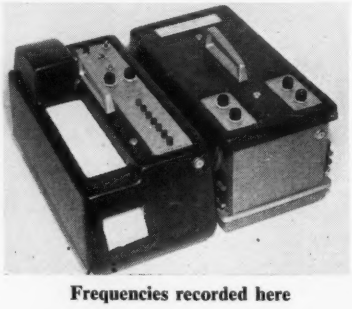
It is ruggedly made (no fragile metal film) and has an easily replaceable ferrite dissipating element. The power monitoring element is a Type 21B silicon crystal and Type N connectors (50 ohms and 75 ohms) are normally supplied. In addition, 93 ohm connectors are available on request. (207)

• • •

Direct-writing oscillograph

A new, two-channel, direct-writing oscillograph, which provides instantaneous, permanent recordings of frequencies as high as 250 cps at one-inch double amplitude has been announced by **Consolidated Electrodynamics Corporation.** The instrument has greater flexibility than any direct-writer on the market today, CEC engineers state.

This equipment, consisting of a Type 5-301 datagraph and a Type 1-133 amplifier, can record voltages from practically any source, including magnetic-tape play-back units, carrier amplifiers, audio amplifiers, d-c amplifiers and telemetering discriminators. Almost any input device is suitable because of the instrument's high input impedance. In addition to frequency response flat to 250 cycles, the datagraph has excellent square-wave and transient response.



Frequencies recorded here

It incorporates a new concept in recording data: a vibrating wire in a strong, specially shaped magnetic field provided by a permanent magnet. The wire burns a contact wherever it touches the electrosensitive paper as it travels over an anvil, providing rectilinear writing. The record may be seen through a viewing window immediately after it is recorded. (208)

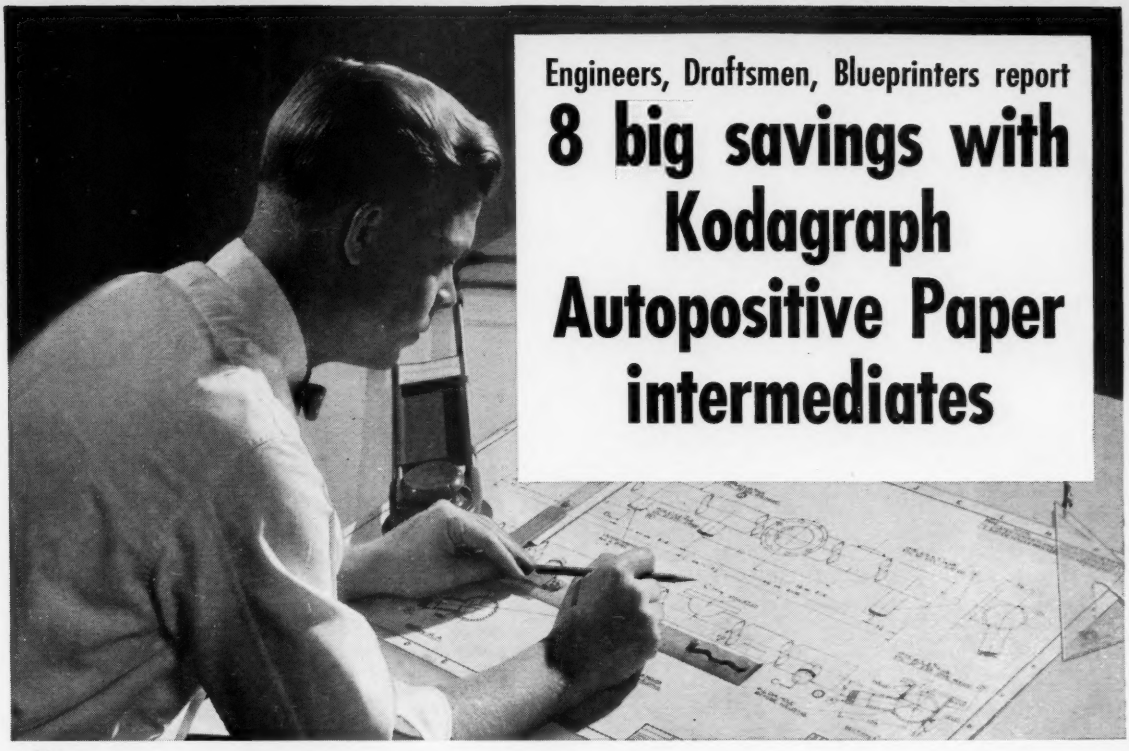
• • •

Hand Tachometer

A new Deumo hand tachometer is available through **Alexander and Orlick Limited.** It is used for measuring the number of revolutions and surface speeds of machines and instruments of any description. Measuring range is 40 to 50,000 rpm, or 12 to 15,000 ft./min. Special measuring ranges are 16 to 20,000 rpm and 24 to 30,000 rpm.

Deumo measures the rpm

The values are read from one entirely symmetrically graduated, neat dial with the utmost accuracy. The symmetrical graduation of the dial is rendered possible by using an eddy current measuring mechanism with reliable temperature compensation. This is a contrast from the unsymmetrical graduation of centrifugal type tachometers. Apart from this, only the main graduating strokes are calibrated on centrifugal type tachometers while the intermediate values are only indicated by strokes. On the DEUMO hand tachometer, as an eddy current instrument, the accuracy of reading is uniform for the entire scale division. (209)



Engineers, Draftsmen, Blueprinters report

8 big savings with Kodagraph Autopositive Paper intermediates

Revolutionary Kodagraph Autopositive Paper, which produces positive photographic intermediates *without a negative step or dark room handling,* brings these savings to drafting rooms large and small.

1. Protects original drawings. Low-cost Autopositive Paper intermediates are used instead of valuable originals in printmaking, reference, mailing, and making revisions.

2. Reclaims drawings which are old, worn, or soiled. Reproducing them on Autopositive Paper cleans up backgrounds, strengthens line detail . . . eliminates redrafting.

3. Improves legibility of prints. Blueprints or direct-process prints made from Autopositive Paper intermediates are consistently easier to read than prints made from original drawings.

4. Reproduces "unprintable" originals. When extra copies are needed of blueprints, drawings on opaque stock, two-sided originals, and other "unprintables," just reproduce them on Autopositive Paper *and you have your printmaking masters.*

5. Speeds revisions of drawings. A popular short cut is to cut out or eradicate detail on an Autopositive Paper intermediate . . . and then add the new detail to this print or one made from it.

6. Eliminates redrafting standard component designs. From a file of standard component designs made on Kodagraph Autopositive Film, select the ones needed and attach to drawing form with translucent tape. Then reproduce on Autopositive Paper, add new detail and the job is done.

7. Simplifies print distribution. Instead of shipping bundles of production prints, send Autopositive Paper intermediates. Mailing costs are saved. Required number of prints can be made at other end. No overstocking this way . . . or running short of prints.

8. Provides photo-lasting copies. Autopositive Paper intermediates, with dense black photographic lines on a translucent white paper base, will not turn yellow or become brittle in the files; will produce sharp, legible prints whenever needed.

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File

New booklets and books written for you

Details are given in a leaflet from the **J. W. Dice Company** of their Carson-Dice electronic micrometers. These use a conventional micrometer screw of high lead accuracy, mounted in a specially designed stand, with a sensitive contact between the micrometer screw and the material being measured. The electronic circuit is sufficiently sensitive to give a positive on-and-off indication with only 5 millionths of an inch displacement at the contacts. An indicating lamp is lighted on the precise dial setting before the micrometer screw exerts any pressure on the work. No current flows between the micrometer tip and the work. There is no arcing or pitting and the tip remains permanently clean without servicing. Feel is eliminated, affording the most accurate measurements entirely independent of the human element.

All instruments are supplied with 3 in. dials having 250 numbered divisions. Each fine division is 0.0001 in., so spaced that readings to twenty millionths (0.000020 in.) can be made readily. (210)

• • •

Rod end applications

Examples of the Unibal rod end applications are given in a booklet published by **The Heim Company.**

This spherical bearing consists of a single ball (instead of a single or double row of balls) rotating in an outer member, and supported by bronze bearing inserts which act as the race.

For centre shaft or end support, the outer member is cylindrical in shape and made in a wide range of sizes. As a rod end for the transmission of power or motion at varying angles, the outer member is made with a lubrication groove, in either male or female design, with lubricator fitting if required. (211)

• • •

Transistorized building blocks

The growing use of such tools as Boolian Algebra and Symbolic logic in the design of complex pulse systems has led, in recent years, to a need for basic circuit elements whose performance mirrors the logical operators of the circuit equations. Ideally, it should be possible to go directly from the symbolic drawing or equation to the physical realization of the circuit without any intervening electronic design stage.

The new Crosley Canada transistorized logical building blocks represent a significant step toward the realization of this ideal. Details are given in a set of leaflets published by **Moffats Ltd.** The units, with their stable operation, high output power and wide frequency range, combine with small size and low cost, provide the digital system designer, logician or computer engineer with a new dimension of freedom. They permit him to employ logical elements in the construction of his systems in much the same manner as the present-day circuit engineer makes use of his resistors and capacitors. (212)

• • •

Baking varnish

A new chemically resistant baking varnish, introduced by the paints division of **Canadian Industries Limited,** is described in a new leaflet.

To be marketed under the trade name Flintrock, the varnish was primarily developed for use as a lining material on metal containers likely to be corroded by the contents of the container or where it is necessary to prevent contamination of the contents through contact with the container's metal walls.

The varnish is said to have high resistance to alkaline materials, mild acids, neutral solutions and a wide range of solvents. It is a one-package clear, golden-colored solution supplied ready for spray application. (213)

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Gas producers

A new bulletin giving product features, dimensions and application data on Neutralene gas producers, which produce purified exothermic gas for protective atmosphere heat treating, is available from **Canadian General Electric Company.** (214)

• • •

Silicone rubber

The properties and applications of Silastic 50 and 80, two exceptionally useful general-purpose silicone rubber stocks, are thoroughly described and illustrated in a new 8-page brochure just issued by the **Dow Corning Corporation.**

Much of the information is data, gathered and published together for the first time. Five graphs and twelve tables are given, including physical properties versus temperature, chemicals, weathering, steam and curing schedules. Tensile strength and elongation are shown as measured during and after heat-aging. Dielectric properties are covered in a special section.

Typical applications of these general-purpose silicone rubbers, in the aircraft, automotive, industrial and domestic appliance fields, are discussed. (215)

Book Department

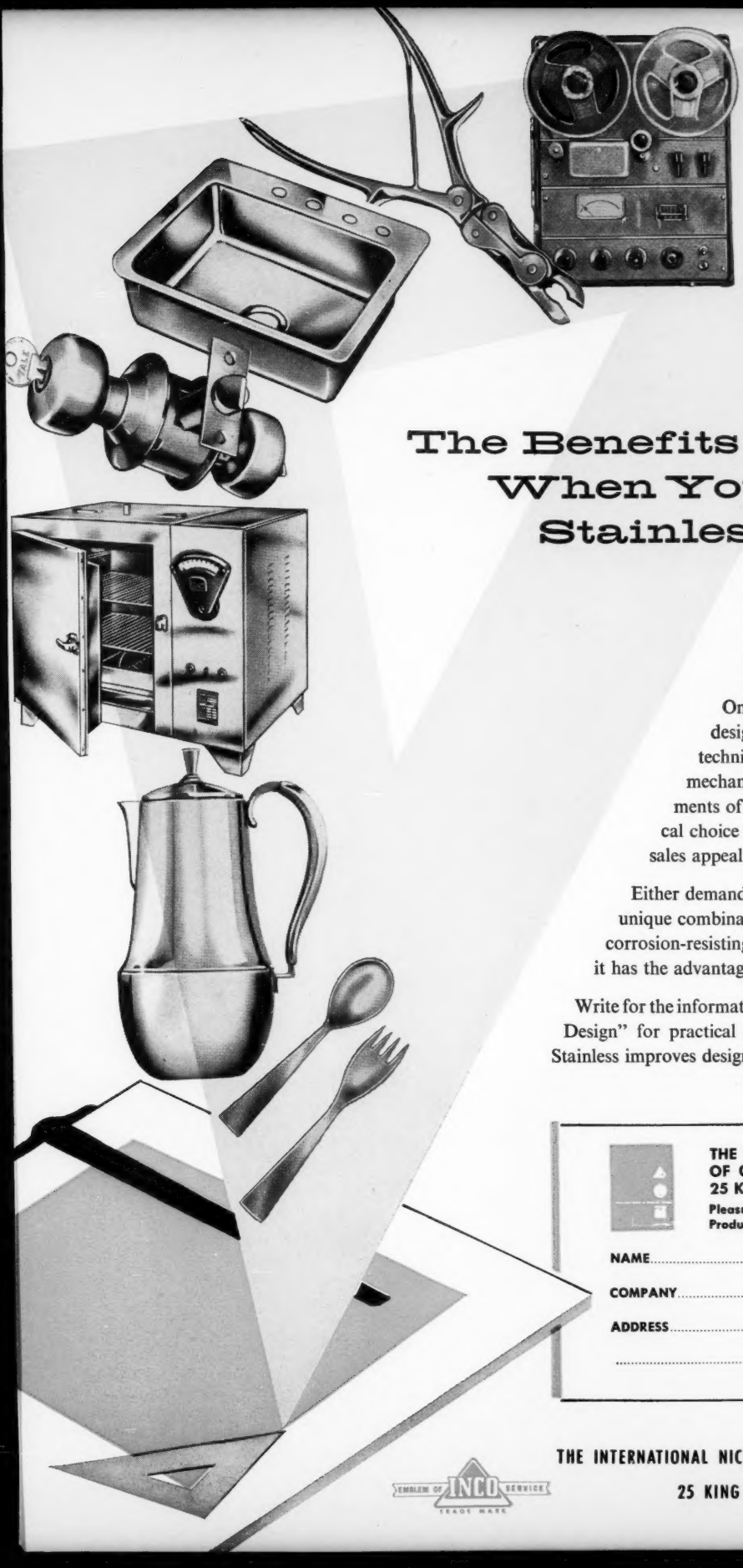
Cams, Designs, dynamics and accuracy.

This book, by **Harold A. Rothbart,** is written primarily for the designer concerned with creating a mathematical function, motion, mechanism, machine or mechanical computer. The cam mechanism most easily fulfills many of these requirements.

The investigation of the broad subject of cams requires both theoretical and practical excursions into kinematics, which considers the relative motion of constrained, rigid members; dynamics, which investigates the masses, acceleration and elasticity of the members; and machine design, which resolves the practical construction and proportion of parts and considers the fabrication accuracy.

Besides diversified cam applications, the book presents advanced chapters in the expanding field of high speed machinery. In this category, vibrations play an essential part. To date, the subject of cams was regarded only as a part of the study of kinematics, and not included were such points as the shape of the acceleration curve, which provides information on vibration, noise and wear; the flexibility and backlash that exist in most systems; and the accuracy of cam profile in terms of its effect on the performance of the mechanism. The foregoing are pertinent to the study of high speed operations, in which the designer can no longer ignore the necessity of more sophisticated mathematical study, related, of course, to the practical phases of the problem. Mathematical treatment is, however, kept to a minimum, only that significance to design being presented. Chapter 7 on polydyne cams and Chapter 8 on the dynamics of high speed cam systems are of such a fundamental nature that the mathematics may be applied to any complex mechanism, cams included. For these chapters the reader should have an understanding of basic vibration theory.

In later chapters a discussion of profile accuracy and errors is offered. A surface may appear smooth to the eye and yet have poor dynamic properties. In the author's experience, only infrequently does the actual cam agree with the theoretical one. Poor manufacturing techniques can seriously impede the functional ability of a mechanism or machine. No attempt has been made to delve into the various detailed methods of cam fabrication. Accuracy of manufacturing is discussed, together with the method used to achieve this precision, as determined by experience and the availability of machine tool equipment. The price of the book is $9.50 and it is published by John Wiley & Sons. It is a good book for the design engineer to have on his book shelf.



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One of the most important jobs of any designer is the selection of materials. For technical reasons the choice may lie in mechanical or corrosion-resistance requirements of the product. An equally valid technical choice may be based on buyer attitudes and sales appeals.

Either demand is met by Stainless Steel. It offers a unique combination of mechanical, heat-resisting and corrosion-resisting properties . . . and at the same time it has the advantage of being a "glamour" material.

Write for the informative booklet, "Stainless Steel in Product Design" for practical examples of where, when and how Stainless improves design.

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Quotes

Points from current papers and speeches

Details of a solar heated house are given in **Trade Topics, Vol. 10, No. 7,** published by the United Kingdom Information Service.

The designer claims that the sun's rays will be used for cooking and heating his new house at about one tenth the normal electriciy bill.

The new invention is stored in the ceiling and concealed from view. The house in which it is to be installed has no chimneys or fireplaces and the sun's heat is trapped by means of a large sheet of plate glass built into the flat roof.

The equipment will be capable of storing solar heat for at least 18 months.

Ventilation is provided by moving the windows, which are fixed on rollers in specially built frames. Interior walls of the new house are double the thickness of normal inside walls and ceilings are made of concrete. Heavy steel girders are placed around the base of each interior wall.

Production models of this new house will cost approximately the same as conventional dwellings.

• • •

Electron microscope

Ever see a human hair that looks twice as big around as a California Redwood?

It's hardly likely. But scientists have. Working with the electron microscope they can now blow things up to 30,000 times their real size, according to the **RCA Victor Electronics Newsletter** for August.

At that rate, even a ten-cent piece would be more than two miles across, so a hair thicker than a tree simply isn't out of the way at all. Nor is a blood corpuscle the size of a 4 ft square sofa cushion.

Researchers are using the microscope to discover a whole new world of the infinitesimally small. Up to now, they've had to assume the existence of many things, and to a certain extent they still do. But even some of the bigger molecules can now be seen.

Officials of RCA Victor, which is handling the big units, explain that, somewhere between 2,000 and 3,000 diameters, the usefulness of the best optical microscope ends, not through any fault of the lenses but by the very nature of light itself. Just as the size of our fingers limits the smallness of objects we can pick up, they say, the wavelength of the light limits the size of those we can see.

The RCA electron microscope, using an electron beam to illuminate the specimen, goes all the way to 30,000 diameters, with useful photographic enlargements to 300,000. It makes it possible to observe and take pictures of tiny particles and bodies actually less than one twelve-millionth of an inch across. Whole new avenues of research—in chemistry, metallurgy, medicine, bacteriology and biology—have been opened.

• • •

pH measurement

Just what is the pH value? What are its restrictions and limitations? What is recommended standard practice? What about measuring pH at high temperatures and pressures, in non-aqueous solutions, in blood—and what is involved in instrumentation for pH measurements? These and other questions were either answered or greatly clarified at a symposium on pH measurement held by the ASTM.

According to **P. H. Bates** (National Bureau of Standards), the operational definition of pH—based on the observed difference of electromotive force of the pH cell when the standard reference solution is replaced by the test solution—has extended greatly the application of pH measurement, but it has led to confusion in interpretation of these measurements. The term pH is therefore losing its precise meaning and becoming instead a synonym for acidity.

John E. Leonard (Beckman Instruments, discussed some of the industrial problems in pH measurements with particular emphasis on measurements at high temperature and pressure such as are encountered in sulphite pulp digesters in the paper industry and in other types of chemical reaction vessels.

W. R. Clark (Leeds and Northrup) described a number of types of commercial instrument for making pH and related emf measurements. He outlined the design characteristics of four basic types—the simple null-detector, the direct-coupled feedback amplifier, the null recorder and chopper-type feedback stabilized type of instrument. All are designed to measure very small emf's without drawing much current from the source.

Henry Freiser (University of Pittsburgh) covered the various aspects of pH measurement as related to analytical chemistry. Specific reactions covered were the Bronsted, Lewis acid-base reactions and oxidation-reduction reactions. He outlined the present state of the theory for calculating various physical-chemical constants based on these reactions.

The symposium may be considered as an important permanent addition to the literature on pH measurement, bringing together as it did a well-rounded exposition of both the theoretical and practical aspects of the present state of knowledge on pH measurement.

• • •

Microscopic crosshairs

Crosshairs used in microscopes and telescopes are often made of platinum wire with a diameter as small as four one-hundred thousandths of an inch, states the **White Metal News Letter** Platinum is used for this wire, so fine as to be invisible to the naked eye, because it will withstand the drastic working operations needed to make it so fine. In its fabrication, a larger platinum wire, surrounded by a heavy silver jacket, is drawn to a small over-all diameter. The silver is then dissolved away, leaving the minute platinum wire core.

Radiation pyrometers

The measurement and control of temperature are basic to all industrial processes. Modern automatic machinery exploits the economy achieved by a continuous flow of product. Such machinery requires instrumentation capable of measuring the temperature of moving material in process for maximum efficiency. Total radiation pyrometers are useful for this purpose, and there is a continuing demand from industry for more sensitive, accurate and versatile instruments.

A paper delivered by **W. Derganc** and **S. N. Howell** at an A.I.E.E. meeting, describes two new pyrometers suitable for a wide variety of industrial and laboratory measurements. They combine good spectral response and high sensitivity with a stability and accuracy adequate for most requirements. These factors are discussed in relation to the design of the pyrometers. The basis for transferring a radiation measurement to a temperature by calibration and some of the limitations involved are also considered.

• • •

Axial-flow pumps

Details are given, in a paper read by **E. A. Spencer** before the Institution of Mechanical Engineers, of tests made on an 11 in. diameter axial-flow propeller pump with impeller and guide blades designed for free vortex conditions, using as a basis modified aerofoil theory. The best over-all efficiency obtained was 82%. Apart from head-flow and efficiency characteristics, measurements were made of velocities and yaw angles within the pump at the design flow of 6 cusecs and these showed where departures from the theoretical assumptions occurred.

Head-flow characteristics were obtained for various impeller blade-tip clearances from 0.015 to 0.060 in. (0.6 to 2.4% blade height) and it was deduced that secondary flows were not confined by any means to the tip region alone.

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For Jenkins Bros. Limited have been making valves — and *only* valves — for decades. This complete dedication to a single superb product has earned Jenkins world-wide fame for the finest in valve manufacture.

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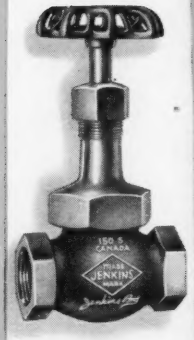

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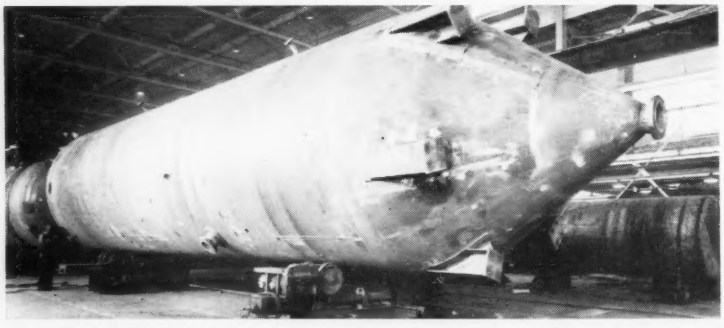
Design news in pictures

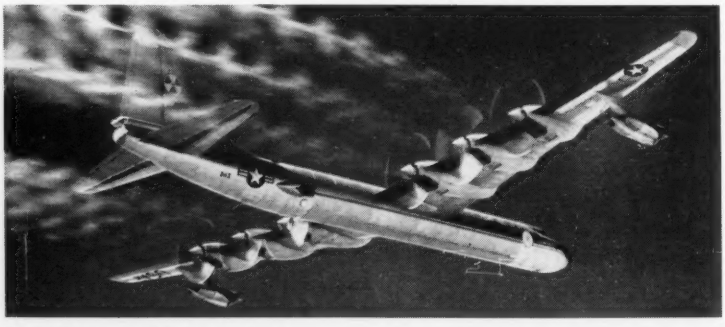
Floating laboratory takes a trip

The Wanderer, containing the latest electronic marine equipment, begins a 1,205 mile voyage from Port Colborne to Halifax. Ship and crew are maintained by Sperry Gyroscope Co. to evaluate and demonstrate the firm's navigational instruments to Canadian shipowners under full seagoing conditions. (216)



Tummy of a sulphate digester

This is the first Inconel-clad sulphate digester to be made in Canada. It is 54 ft. high from nozzle to nozzle and has an internal diameter of 11½ ft. The shell is built in four courses and therefore has five circumferential seams welded from the outside by the submerged arc process. It weighs 50 tons. (217)

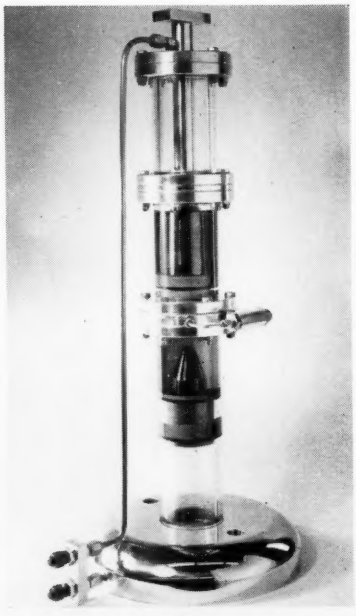


Operating reactor takes to the air

This is the first picture released of the Convair B-36 intercontinental bomber in flight with an operating atomic reactor aboard. Vapour trails from the plane's six pusher engines indicate its great altitude on the test flight. Airscoops aft of the wing cool the reactor during the plane's operations from Fort Worth, Tex. (218)

Resin daylighting panel

A new glass fibre-reinforced resin structural panel for daylighting is available. It's designed to match profiles with all the latest roofings. (219)

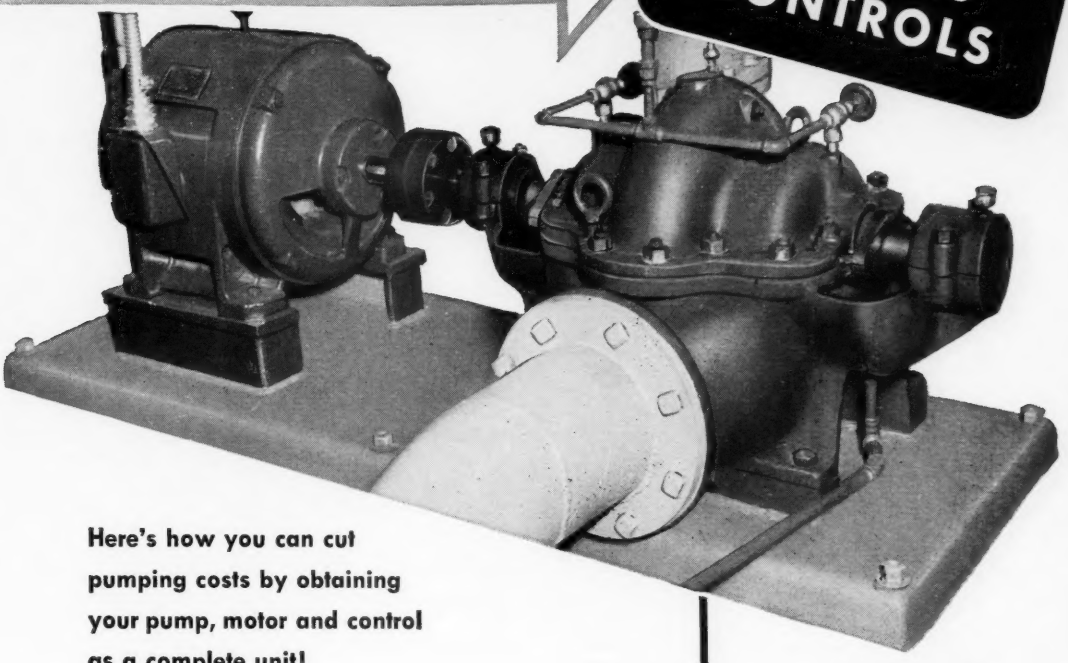


Dynamic shock tester

The Hyge Actuator accurately simulates shock experienced by equipment in actual use. A part plastic demonstration model is pictured here. (220)

This "PACKAGE DEAL" can save you money

ALLIS-CHALMERS PUMPS MOTORS CONTROLS



Here's how you can cut pumping costs by obtaining your pump, motor and control as a complete unit!

1 You save on engineering time and costs because all components are co-ordinated, all parts match up properly, selection is faster, easier.

2 You save on installation costs because your pump and motor arrive as a complete unit, perfectly fitted, ready to go to work.

3 You save on service, because responsibility for performance rests with only one company — an important advantage.

4 You save in operation, because with all components engineered to a single set of standards, and designed to operate together, mechanical and electrical factors can be matched for maximum efficiency and economy.

MORE GALLONS AT LESS COST

Efficiency in the high 80's with reduced power consumption and lower maintenance—these are the principal factors that make this single stage, double suction pump so popular. Other advantages include:

Low cost replaceable parts protect casing and shaft at all points of wear . . . Ease of maintenance, with easy access to packing. Complete range of materials including bronze fitted, stainless steel, Ni-Resist, or special coatings . . . Wide range of sizes.

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PUMPS

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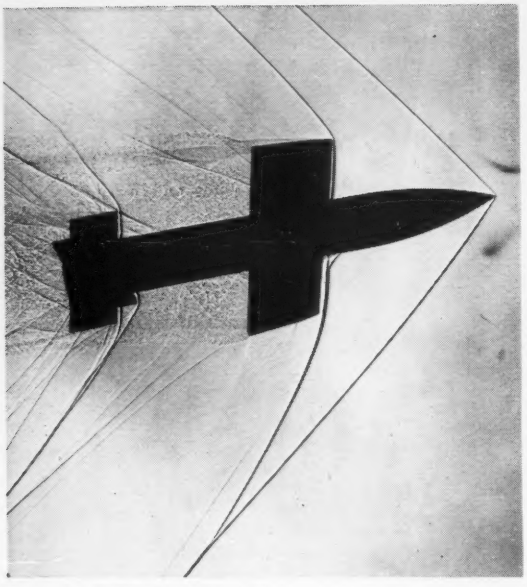
Some modern designs making news today



Research model at Mach 1.6

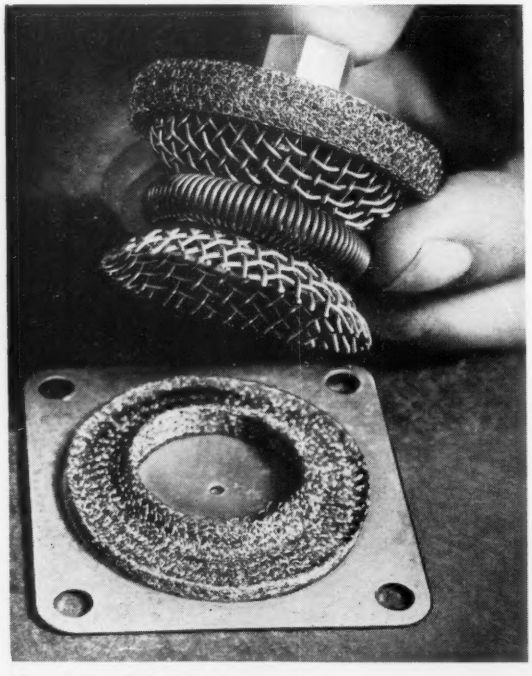
Caught in flight by the shadowgraph technique, this free-flight stability research model shows the complicated pattern of shock waves and vortexes associated with high speed flight. The 7 in. model was fired into still air. (221)

More vortexes in a wind tunnel

Vortexes generated by a wind tunnel model are made visible by the vapor screen method. Water vapor introduced into the tunnel forms fog in the air stream and vortexes appear in the light plane as dark spirals. (223)

Quick change to a tractor track

A new traction device currently under trials by the Army may enable heavy cargo trucks to operate efficiently in soft spongy ground. The tractor-like lugs can be quickly adjusted in a few minutes by a trained two-man team. (222)



Mounts for electronic components

A coil spring tempers the motion of a concave-convex spring to proxide maximum vibration protection in aircraft and missiles. With normally four mounts to a component a fighter may use 500, a bomber up to 3,000. (224)

polythene . . . your key to greater efficiency, reduced costs, increased sales

. . . has all these exceptional properties:

light
tough
non-toxic
moisture-proof
chemically inert
corrosion resistant
exceptional dielectric properties
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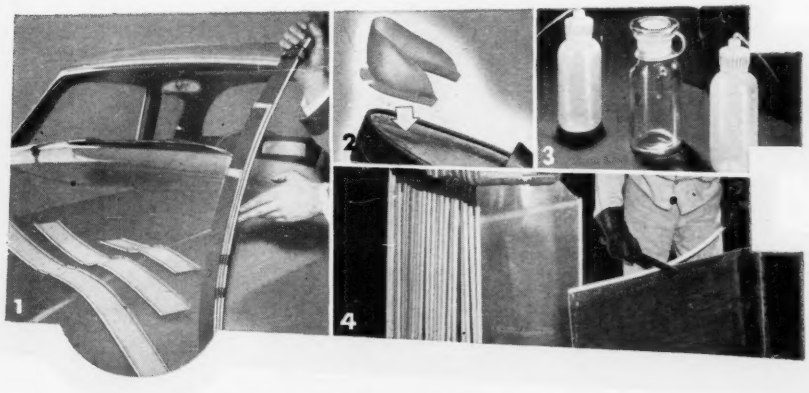
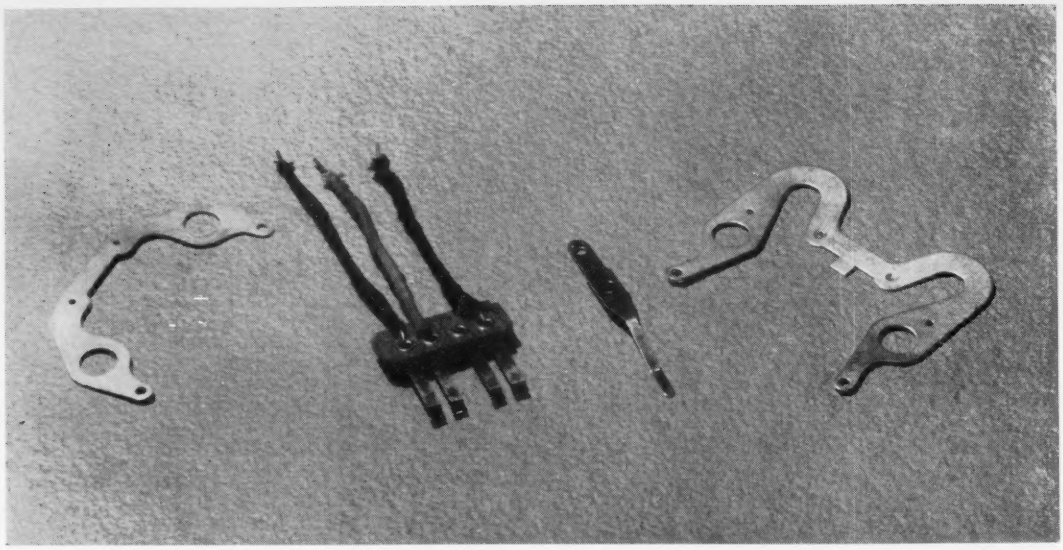
Polythene edges on cathode plates prevent zinc deposits from joining around sides, assuring easy removal.



polythene

PLASTICS DIVISION - SUPPLIERS OF PLASTIC RAW MATERIALS



An assortment of contact fingers and conducting spring members made from the silver-magnesium-nickel alloy.

This soft silver hardens by heat in air

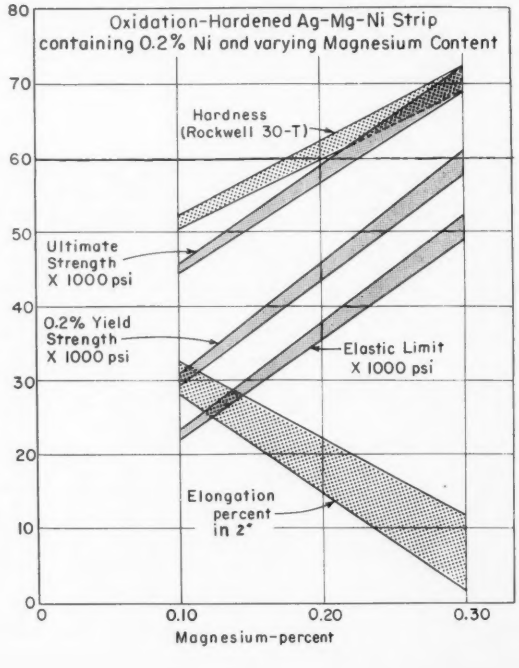
The outstanding characteristic of this new silver alloy is the ease with which it can be worked and then irreversibly hardened by heating in air

A new oxidation-hardenable high silver alloy, offering an unusual combination of electrical and mechanical properties, has been developed by Handy and Harman, manufacturers of silver alloys for industrial use. The alloy is a silver-magnesium-nickel composition, normally consisting of about 99.53% Ag, 0.27% Mg, 0.20% Ni.

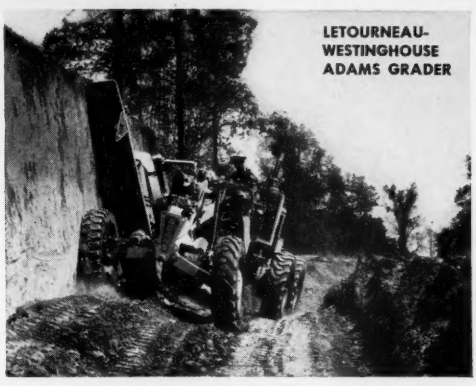
The new alloy is highly resistant to softening, has a low creep rate and for all practical purposes does not anneal at elevated temperatures. In the as-received (annealed) condition, this silver-magnesium-nickel alloy is soft like fine silver or copper, and finished parts can be formed (by stamping, drawing, bending or spinning) usually without anneals. If annealing is necessary, it can be done in 15-30 minutes in air at 700° F or in a non-oxidizing atmosphere above 700° F. Permanent oxidation hardening is produced at 1200-1475° F, the time and temperature cycle depending on the thickness of the piece.

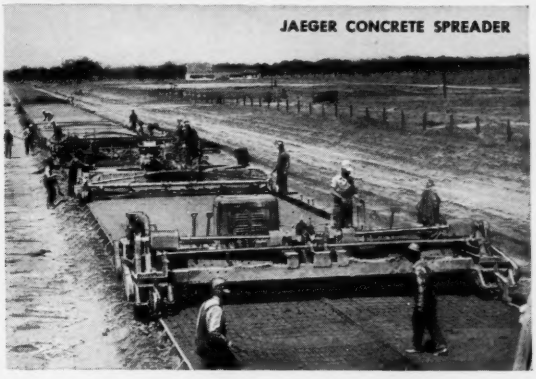
In the oxidation-hardened condition, the tensile properties at room temperature are similar to those of hard rolled coin or sterling silver. At elevated temperatures, the hot hardness and strength are considerably better than for hard-rolled silver-copper alloys. However, at elevated temperatures the hardness and strength are accompanied by reduced ductility and the material tends to fracture (rather than creep) under high stresses. Nevertheless, with proper design to avoid high stress, the alloy offers some unusual performance advantages at moderately elevated temperature because of its high conductivity, low creep rate and permanent hardness. ★

PHYSICAL PROPERTIES AT ROOM TEMPERATURE

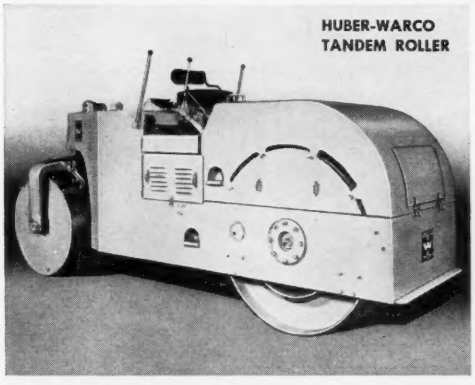


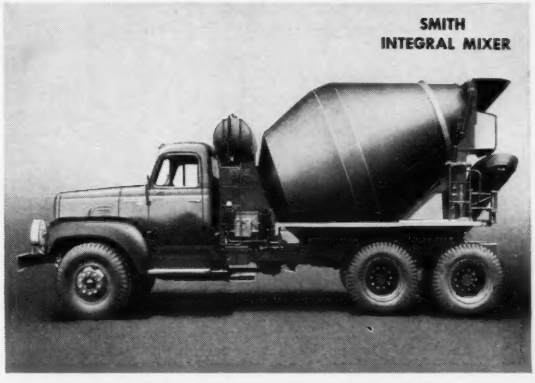
Designers of the latest types of road


LETOURNEAU-WESTINGHOUSE ADAMS GRADER


JAEGER CONCRETE SPREADER

building and construction machines enjoy


HUBER-WARCO TANDEM ROLLER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ATHEY SELF-PROPELLED LOADER

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As one customer wrote: *"We are seldom able to obtain the prompt and pleasant attention which you have given us in developing these . . . joints".*

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BLOOD BROTHERS MACHINE DIVISION

ROCKWELL SPRING AND AXLE COMPANY

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UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

Letters

Readers' viewpoints . . .

Our Digest of articles is co-operating with the European Productivity Agency in supplying occasional digests of interesting articles dealing with Canadian developments, which have been published in Canadian scientific and technical journals.

We believe the article "How fast can you wrap a stator core?" appearing in your June 1956 issue would be of particular interest; and we are, therefore requesting permission to make a digest of it to be published in Technical Digests.

We would also appreciate it if you have and could spare copies of the four photographs accompanying the article for inclusion in the digest.

In all these digests full acknowledgement is made to the periodical from which it is taken.

from F. G. Green, Officer-in-Charge, Technical Information Service, National Research Council, Ottawa 2.

Permission was willingly granted and photographs supplied—Ed.

• • •

We have found another article published in your magazine of such interest that we would like to send a digest of it to the European Productivity Agency. This article, "Nylon tube bending mandrels save time" appears on page 47 of your July 1956 issue.

We would appreciate it very much if we could have your permission to prepare a digest of it for submission to the EPA. We would also like to take a photoprint of the illustration accompanying the article.

As mentioned previously all credit is given to the publication from which an article is digested.

from F. G. Green, Officer-in-Charge, Technical Information Service, National Research Council, Ottawa 2.

• • •

Answer to query

Under readers viewpoint, Design Engineering for March 1956, a query by John Whiley on sustaining tones or notes has recently been brought to my attention. I believe your correspondent may find the answer in Canadian Patent 461969 "Acoustic Feed Back for Musical Instruments."

from S. Hamilton, Ste 9, Pollock Apts., 414 Edmonton St., Winnipeg, Man.

This interesting information has been passed on to John Whiley—Ed.

• • •

Back numbers of D.E.

We have received a request from our Aeronautical Research Laboratories asking could we obtain a copy of the following publication which we understand is published by your establishment: Design Engineering (Canada), Volume 2, 1956, Nos. 2 and 3.

Would it be possible for you to let us have a copy of this publication? If so, could you advise us of the cost and we shall forward you a cheque.

from A. S. Cooley, Defence Production and Supply Representative, Australian Joint Service Staff, Box 4837, Washington 8, D.C.

A copy of Vol. 2 No. 3 (March 1956) was forwarded. Unfortunately a copy of No. 2 was not available—Ed.

• • •

Finish for stainless

In your July 1956 issue, pages 52 and 53, an article describes a finish for stainless steel by Ateenate, Inc., Boston, Mass.

We have a problem of marking various equipment which is subjected to excessive corrosion and it would be of great assistance to our firm if we could obtain further knowledge of this new process for integrally marking the surface of stainless steel.

from R. Wheeler, Maintenance Engineer, Anglo-Canadian Pulp and Paper Mills Ltd., P.O. Box 1487, Quebec.

Further information was supplied by Ateenate Inc.—Ed.

• • •

Call for the author

Some months ago your magazine ran an article on epoxy resins. Would you kindly advise the author and his address.

from D. B. Potter, Guild Metalcraft Co., Box 1, O'Connor Drive P.O., Toronto 16.

This information was supplied—Ed.

• • •

Address wanted

Would you please forward the address of Tormag Transmissions Ltd., mentioned in an article on transmissions in your latest issue.

Your early reply would be appreciated.

from D. W. Burley, Assistant General Purchasing Agent, North American Cyanamid Ltd., Niagara Falls, Ont.

• • •

Enjar wheel

In the Autumn number of Rubber Developments, the Board's quarterly magazine, we are publishing a note on the Enjar wheel invented by the late Mr. MacLean of Windsor, Ont.

I would be grateful for your permission to reproduce the diagram of the heavy duty Enjar wheel from your issue of November, 1955.

from R. A. F. Thistlethwaite, Assistant to the Press Officer, Natural Rubber Developments Board, Market Buildings, Mark Lane, London, E.C.3, England.

Permission willingly granted—Ed.

Neoprene

(continued from page 45)

far the largest application of neoprene in the electrical field is its use as a protective covering, including jackets for all types of rubber insulating cable, as a covering in line wire and service drop wire and as a protective covering over lead-sheathed cable.

Adhesion

Adhesion, or the strength of bond between rubber and another material, is generally measured in one of three ways: (1) by application of a load to cause stripping or peeling, (2) by application of a load normal to the plane of the bond, or (3) by application of a shear load.

The bond strength of neoprene to fabrics compares favorably with the best obtainable from other elastomers. It wets the fabric and since unvulcanized neoprene has somewhat greater plasticity than many other elastomers, it displays excellent flow characteristics. Neoprene also shows high bond strength when applied to metal by the usual methods, bond strengths greater than 1,000 psi. being obtained easily.

Permeability

Neoprene is less permeable to most gases than natural rubber, as is shown by Table 2.

It is well known that chemically saturated materials, such as polyethylene and butyl rubber, are exceptionally impermeable to many gases. Some liquids are much more soluble in certain elastomer films than others. In considering permeation by volatile liquids, therefore, the ease with which the liquid dissolves in the film becomes of prime importance.

Hydrocarbons, for example, are far more soluble in natural rubber than in neoprene and, as a result, neoprene is much less permeable to those liquids.

Neoprene is used in a great number of applications where its low permeability to many different types of liquid and gas is an advantage. These include gaskets, seals, balloons, diaphragms and hose.

Weathering and sunlight resistance

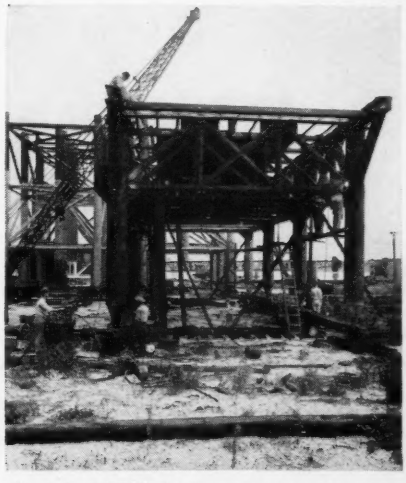
Laboratory tests, and a large amount of long-term service experience, have established neoprene compositions as definitely better than the best natural rubber when exposed to the elements. In fact, the order of magnitude of the resistance to deterioration by weather and sunlight is completely different for the two elastomers. This has been established by both static and dynamic exposure tests. Neoprene specimens have remained

(continued on page 76)

"3M" Coating EC-244 is used to protect underground manifold piping, valves, etc., against soil corrosion.

"3M" Sealers are widely used in the aircraft and automotive industries.

"3M" Adhesive EC-770 being applied to the inside edges of hot air register for bonding a felt strip gasket.



Applying "3M" vinyl protective coating to a part of an offshore drilling rig.

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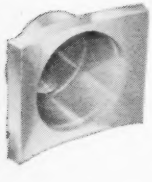

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Neoprene

(continued from page 74)

serviceable after 21 years of outdoor exposure and to all appearances still had many years of useful life ahead.

Resistance to natural aging

During storage, the physical properties of a rubber product may change. It may crack or become soft and gummy or hard and inflexible. Although once a major problem, rubber technologists in recent years have made huge strides in developing compositions that resist storage degradation. Neoprene resists deterioration during storage much better than natural rubber. If storage conditions are ideal (as in a controlled laboratory test) natural rubber gives excellent results.

It has been during actual storage in warehouses and on shelves that neoprene's better aging properties have been established.

Resistance to ozone and corona

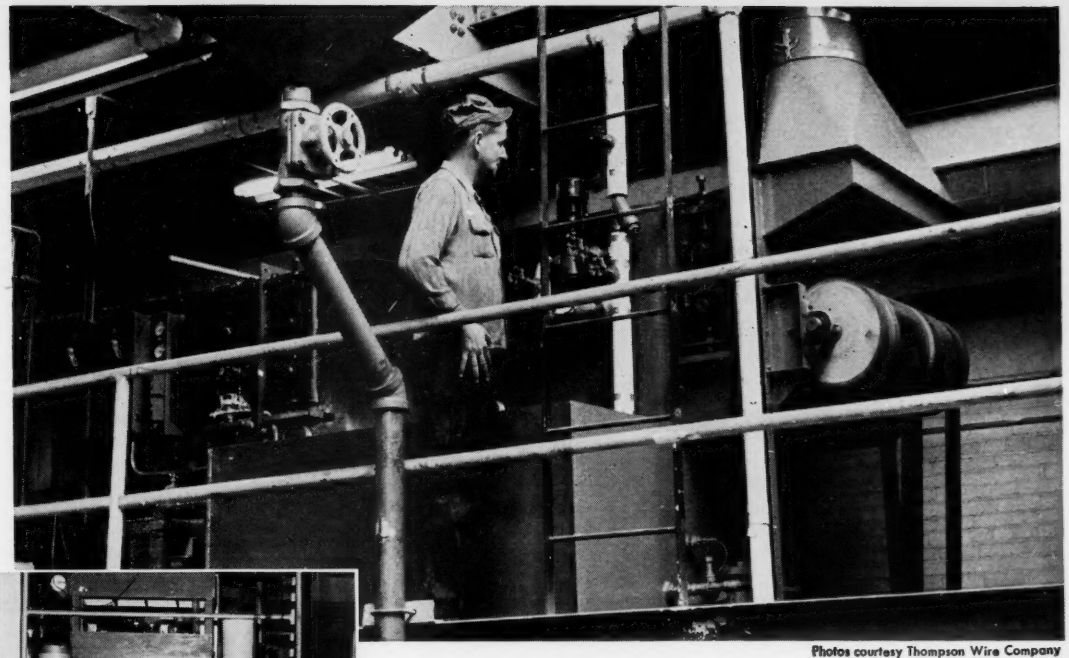
Ozone attack is usually evidenced by the formation of a few deep cracks or a myriad of small cracks. These occur at right angles to the direction of applied stress and may cause rupture of the sample if the stress is high. Corona is the electrical discharge which takes place in the atmosphere around high-voltage cable. At night, under some conditions, corona is visible as a violet glow around high-voltage lines. Corona causes formation of ozone which in turn may cause cracking of stressed rubber articles. This ozone may form in air occluded within the cable as well as in the air around it.

One of neoprene's outstanding properties is its resistance to cracking under tension when exposed to ozone. In this respect it is markedly superior to natural rubber and to general purpose synthetics.

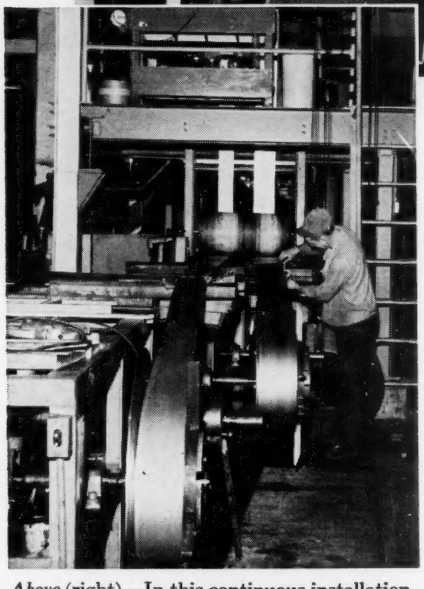
Heat resistance

It is difficult to make comparisons between natural rubber and neoprene in this regard, because high temperatures affect each in an entirely different manner. Natural rubber, even when compounded for the best heat resistance, generally becomes soft and gummy when exposed to high temperature for a long time. Neoprene, on the other hand hardens slowly under the same conditions.

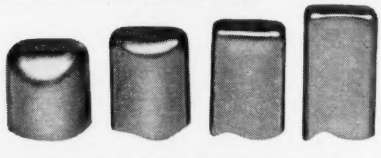
The extent to which either softening or hardening is undesirable depends on the particular service the resilient product must perform. A large number of field applications covering a wide variety of uses and service conditions, however, indicate that neoprene usually remains serviceable much longer than natural rubber and most other elastomers. ★



Photos courtesy Thompson Wire Company



Above (right)—In this continuous installation, strip steel is treated with Bonderite, then with Bonderlube lubricant. *Below*, treated strip is re-coiled as it comes out of the machine, Bonderite-Bonderlube treated.



Successive steps in forming a small case from Bonderite and Bonderlube treated strip.

For better performance in the forming dies . . .

Get steel strip, mill-treated with

BONDERITE *and* BONDERLUBE

Here's a service that can mean real savings in your cold forming operations. Buy mill-treated steel, in coils, treated with Bonderite and Bonderlube and ready for the dies.

This specially treated strip, with its Bonderite-Bonderlube coating, is used for many products and components made by cold forming. The combination of Bonderite and Bonderlube provide such effective lubrication that severe deformations are possible without marring surface finish. Tools and dies last longer, production may be greatly increased, production costs are reduced.

Investigate mill-treated steel strip with Bonderite and Bonderlube. Ask your strip supplier about this new development.

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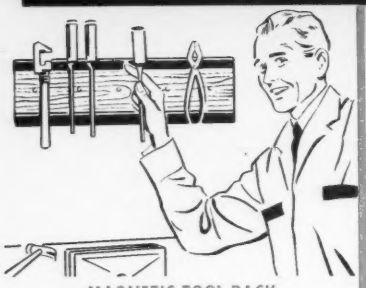
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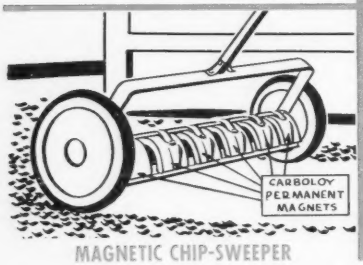
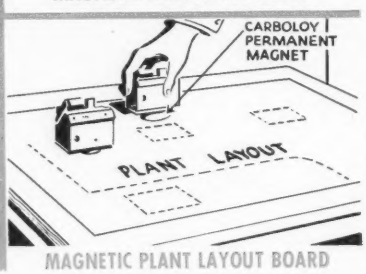
MAGNETIC I-BEAM CONVEYOR



MAGNETIC CHIP-SWEEPER



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Welding aluminum

(continued from page 48)

The inert metal arc process is particularly suitable for the manual welding of aluminum and its alloys in all positions. It is used to the greatest extent on material over 0.125 in. thick. When welding the thinner gauges, very high welding speeds are required and these make accurate manual control of the torch difficult. However, for certain applications and with suitable equipment, the useful range of this process has been extended to material as thin as 0.032 in. Inert metal arc machine welding of aluminum is practical in thicknesses over 0.032 in. There is no upper limit to the thickness of aluminum that can be welded by manual or machine inert metal arc welding.

Inert metal arc welding can only be used where the addition of filler material is permissible. Joints must be so designed that they are sufficiently accessible for manipulation of the torch and visibility of the arc, both necessary conditions for good welding.

The figure illustrates the manual inert metal arc welding process in the horizontal position. In manual welding by this process, speeds up to 50 in. per min are easily obtained. Figure 4 illustrates the inert metal arc machine welding of 5/16 in. Alcan B54S-F hopper car sides at a speed of 35 in. per min. In other applications, speeds up to 15 ft per min have been reached.

High speed aluminum welding makes possible the economical fabrication of a wide variety of assemblies. Strong and ductile welds can be made which will withstand rigorous service. The confidence placed in the high speed welding of aluminum today is illustrated by its wide acceptance for applications such as shipbuilding, large storage tanks, mine cars and skips, truck and transport bodies, railway rolling stock such as tank cars, hopper cars, refrigerator cars, hot-water tanks and a host of other applications.

High speed welding, combined with careful design and a full knowledge of the characteristics of aluminum, will result in serviceable products produced at prices which are quite reasonable. ★

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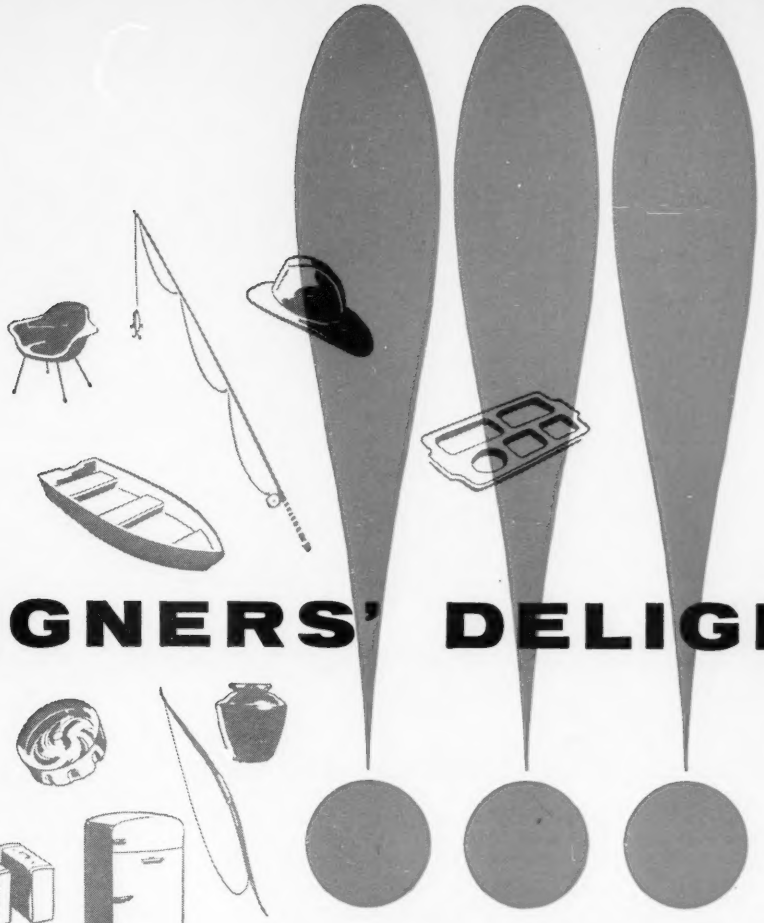

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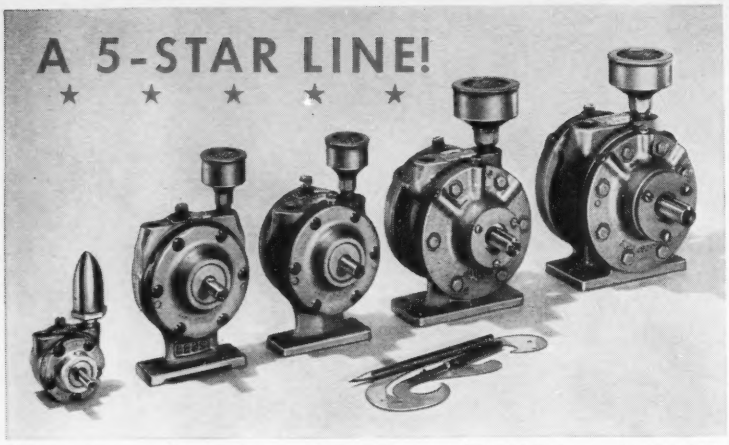

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10. Mechanically simple, neat in appearance.

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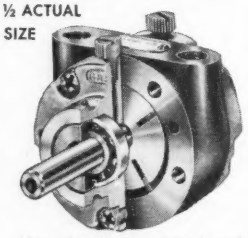
MODEL 1 AM ½ ACTUAL SIZE



Note the simple principle and trouble-free construction.

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2 AM	1,000 2,000	0.22 0.40	0.35 0.57	5¼
4 AM	1,000 2,000	0.48 0.78	0.73 1.10	7½
6 AM	500 2,000	0.40 1.30	0.65 2.00	18
8 AM	500 1,500	1.00 2.30	1.45 3.80	25

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SEE OUR CATALOG IN SWEET'S PRODUCT DESIGN FILE

Circular arcs

(continued from page 54)

Ellipse fairing

Unlike the parabola, the two-arc method for the ellipse follows the true curve closely if P (fig. 4) is on or near the true curve. If greater accuracy is required however, the number of arcs can be increased, as for the parabola.

Conics in general

If a control point is used, it is first necessary to determine the tangent of the conic passing through this point. This is explained in Appendix III. The two parts of the curve are then approximated, each by two circular arcs meeting on the diagonal of the containing parallelogram.

Continuous curves

To approximate continuous curves by a series of circular arcs, text books usually give an indication that they can be fitted in. On investigation it was found impracticable to keep the same tangents as those of the original curve or to take equidistant points thereon, but a practical method consists of fitting in a series of isosceles triangles, as indicated in fig. 6. This has the advantage that the number of arcs is greatest where the curvature is also greatest.

Starting at a convenient point, such as an end or vertex, draw an isosceles triangle with its apex as close as possible to the centre of curvature, and with the base angles touching the curve. A convenient vertical angle is usually 15 deg, but an angle near this value, an exact fraction of the total angle turned through by the line, may be taken. Follow up with a series of similar isosceles triangles touching the curve as shown and use their apexes as the centres of the required arcs. An adjustment may be necessary near the end of the line, but for very precise work it is possible to adjust the radii into geometric progression. This was actually tried out with a series of ellipses but after laboriously adjusting the radii into geometric progression, results practically identical to those under "8-arc ellipses" were obtained. The idea of having the corresponding angles in arithmetic progression was also tried but found to be mathematically impossible.

In design work, of course, it may be found preferable to fit in isosceles triangles initially and then draw in the appropriate arcs.

This method can also be used for aerofoils, fuselages and so forth if it is desired to give greater regard to curvature than station points.

APPENDIX I **To draw an ellipse in a parallelogram**

Several geometric constructions were investigated but found to be generally

(continued on page 84)

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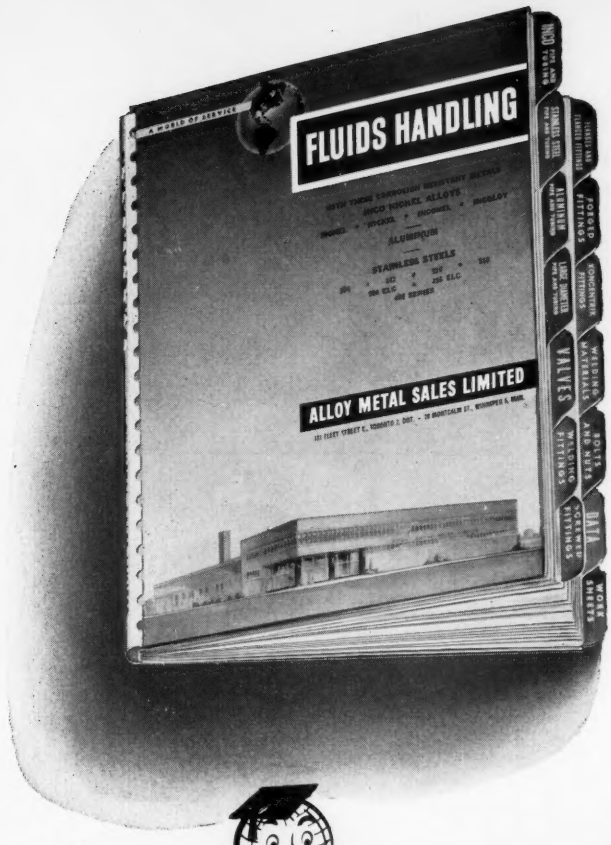

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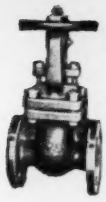

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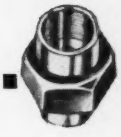

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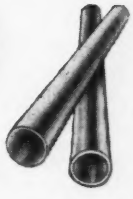

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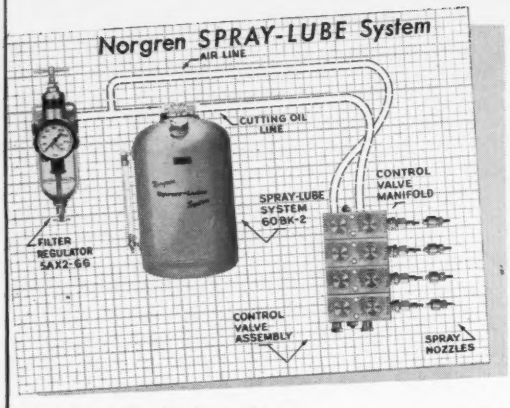

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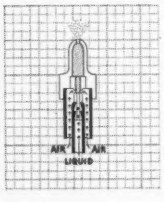

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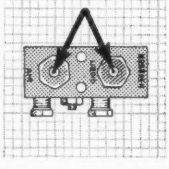

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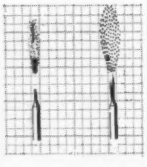

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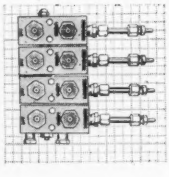

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Circular arcs

(Continued from page 80)

unsatisfactory. A thorough mathematical investigation was then carried out, giving the following simple construction:

(1) Construct fig. A1 to determine the ratio a^2/b^2.
(2) Construct fig. A2 to determine ϕ.
(3) Draw axis to angle ϕ (fig. A3).
(4) (Fig. A4) Join centres of quadrants or otherwise determine centre of intercept of axis of ellipse on parallelogram. Then draw semi-circle (or part) on intercept.
(5) Erect perpendicular from end of centre line of parallelogram to axis and continue backwards to intersect semi-circle.
(6) With center O and radius to intersection, draw arc to intersect axis at end of major axis of required ellipse.
(7) By similar construction determine end of minor axis.
(8) If required, ϕ is given by:

$$\text{Tan } (\phi - 2\theta) = \frac{a - b}{a + b} \text{ Tan } \theta$$

Major axis is given by the geometric mean of the effective centre line of the parallelogram and the intercept of the axis of the parallelogram projected thereon (or vice versa). The ellipse can be drawn in by recognized methods or approximation by circular arcs as stated.
(a) by drawing the containing rectangle in which case for the 4-arc method the arcs may not be quite tangential to the sides of the parallelogram.
(b) draw two arcs in each quadrant as indicated in the text and in fig. A3.

APPENDIX II **To draw a parabola in a parallelogram**

(1) (Fig. A5) Draw a circle to touch OB at O and pass through A.
Repeat for OA and B.
Intersection F of circles is focus of parabola.
(2) Through F draw straight lines parallel to diagonal OC giving axis of required parabola.
(3) Draw perpendicular to diagonal OC through centres of true tangent, i.e. from A and B to *axis* giving vertex V thereon.

Note. If AOBC is a rectangle, F is on the diagonal AB at the foot of a perpendicular from O.

The parabola can be drawn in by recognized methods or approximated as described in the article.

Radius of curvature at V = 2VF
Radius of curvature at A or B = $\frac{(\text{tangent})^3}{\text{subtangent X perpendicular}}$

Note. If AO and BO are nearly equal, the axis passes practically through the centre S of the circle in fig. 4 but this must not be assumed true in all cases.

(Continued on page 86)

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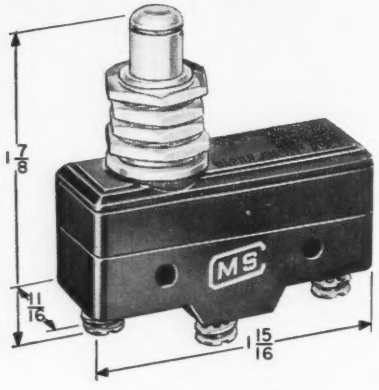

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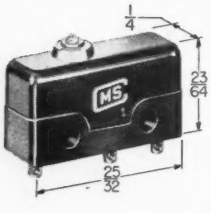

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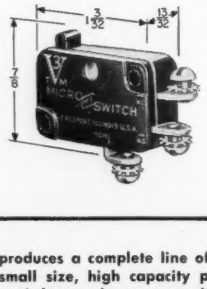

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Circular arcs

(Continued from page 84)

APPENDIX III **To draw a conic section through a control point**

(1) Join AP and BP (fig. A6).
(2) Through O draw an arbitrary line OD intersecting AP and BP at M and N.
(3) Through A and B draw straight lines through M and N respectively intersecting each other at C, a point on the required curve. For the purpose indicated in the article however, it is necessary to determine only one point C, so that PC produced intersects AB at E reasonably near B.
(5) Join ME intersecting OB at T.
(6) Join TP giving required tangent at P.

Actually in some cases of a parabola fairing it may be preferable to use a control point at the middle of a tangent joining the middles of OA and OB.

For a quadrant ellipse the control point is on a line from O to the middle of AB, dividing it in the ratio 2/1.

Conclusion

It is seen from the foregoing exhaustive investigation: (a) The closest approximation to an ellipse by 4 arcs is obtained with the meeting on the true ellipse in which case the centres are on a straight line through the corner of the containing rectangle, the direction being obtained by the construction given. (b) For fairing curves, best results in general are obtained for two arcs by arranging the meeting on the diagonal of the containing parallelogram. Approximations to particular curves are given in the text.

As indicated in the introduction, the investigation was carried out owing to the diversity of methods appearing in publications and on the basis of the results given it is strongly recommended that full consideration be given to employing these approximations whenever possible, to facilitate drawing and reduce manufacturing costs to an absolute minimum. ★

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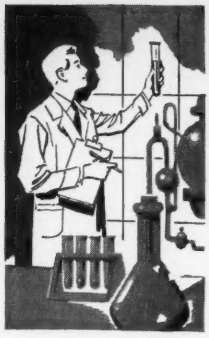

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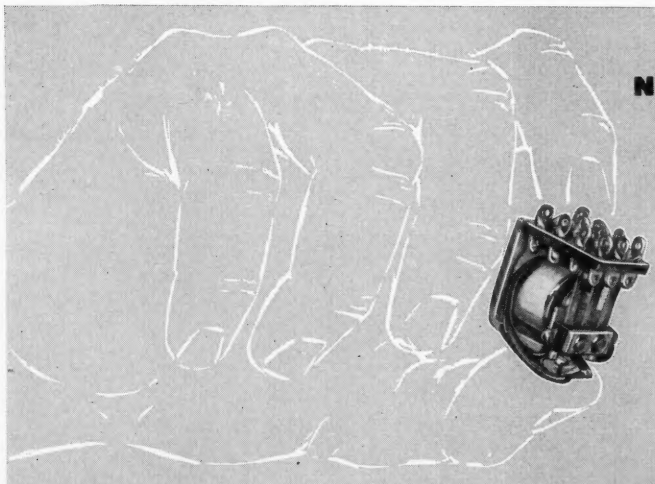

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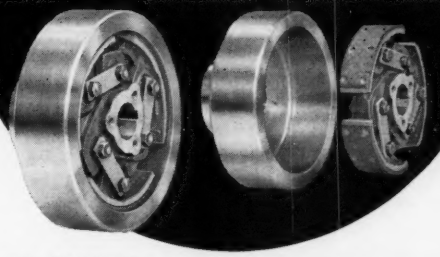

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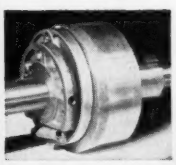

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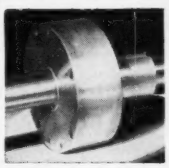

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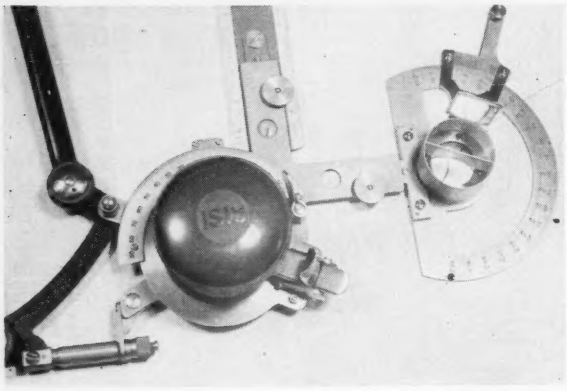

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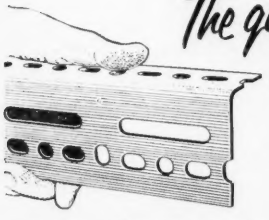

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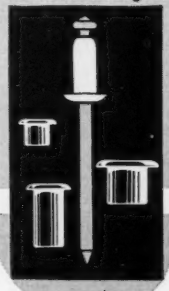

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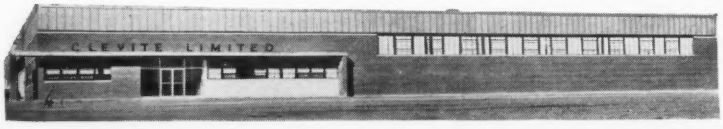

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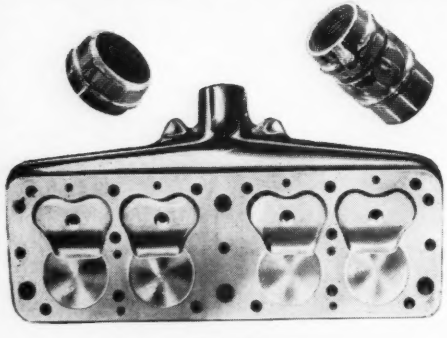

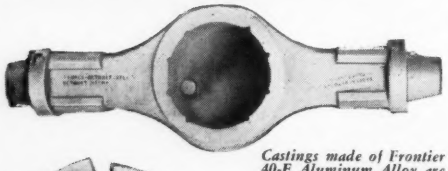

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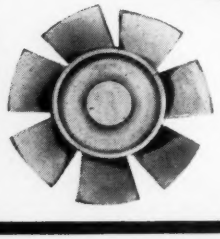

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Editorial

A step in the right direction!

A most significant event took place last month at the National Conference on Engineering, Scientific and Technical Manpower, sponsored by A. V. Roe (Canada) Ltd., and held at St. Andrews, N.B.

This was the formation of the Industrial Foundation on Education, with Crawford Gordon, Jr., as chairman of the advisory committee, and Stanley H. Deeks of Orenda Engines, Ltd., as executive director. The organization has four main functions: (1) to speak for industry in matters of education; (2) to represent industry in any national attack on the broad problem of skilled manpower shortage, and related educational needs; (3) To explore the role of industry in supporting education at all levels; (4) to carry on research in education in the light of industry needs.

Doctor O. M. Solandt, vice-president of the CNR, has predicted that over the next 25 years, 6,000 engineering graduates will be required each year, and since this is almost four times as many as are turned out by the schools right now, something pretty drastic will have to be done, and soon, by the Foundation.

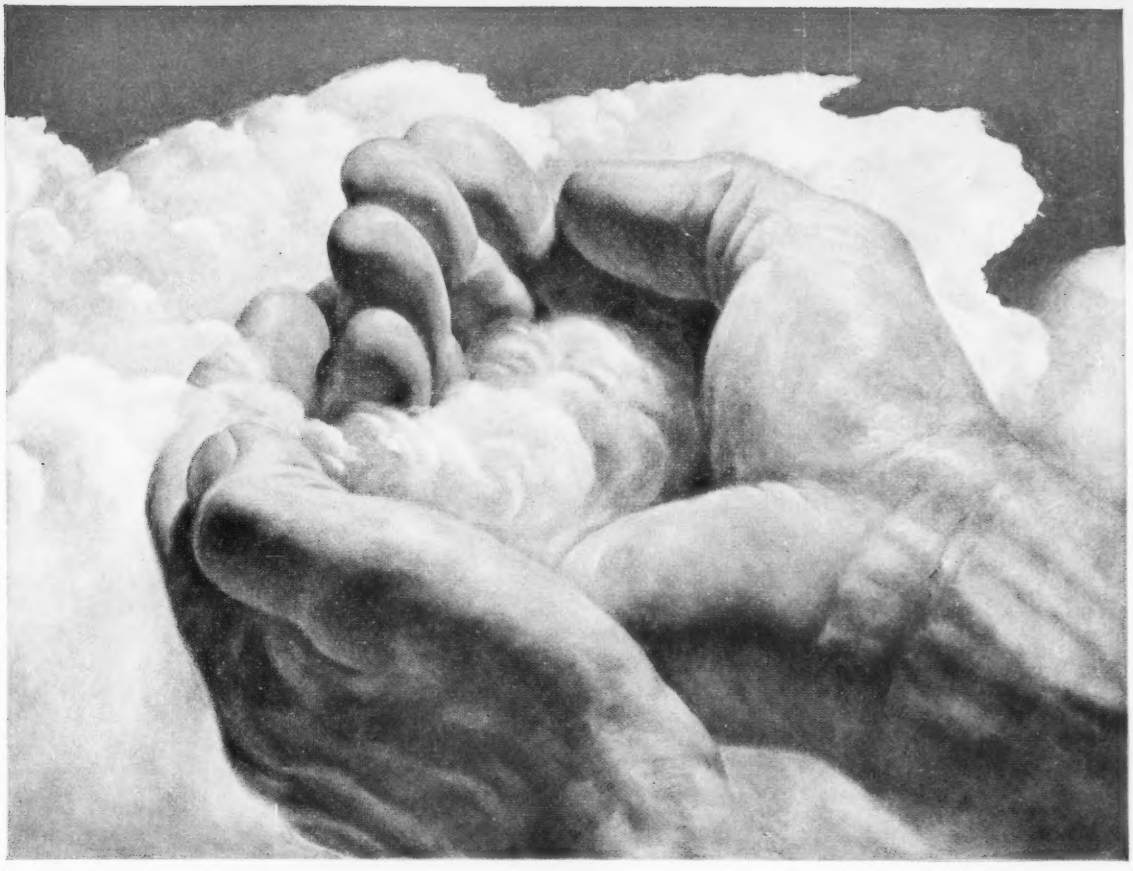
It is very gratifying to know that even before the Manpower Conference, there was a plan afoot at the University of Western Ontario's Waterloo College for a six-year technical and engineering course. Students will be admitted after Grade 12, and the course leads to a diploma after the first three years, or to an engineering degree at the end of six years, if the course is successfully completed. There will be lectures and laboratory work on technical subjects and on the humanities — to make a better-rounded engineer.

It is intended to train two classes a year, and the students will alternate with 13 weeks in college, and then 13 weeks in industry, during which time they will be getting good practical experience, and being paid as well.

Another approach, as has been pointed out in an earlier DESIGN ENGINEERING editorial, would be to adopt the National Certificate scheme of part-time study, used so successfully in the British Isles. This suggestion has, in effect, also been made quite independently by Doctor H. H. Kerr, principal of Ryerson Institute of Technology.

We shall follow the progress made by the Foundation with great interest, and from time to time have occasion, no doubt, to report on it. At this stage, however, we should like to make generally known our willingness to assist the new director in any way we can.

William Morse.



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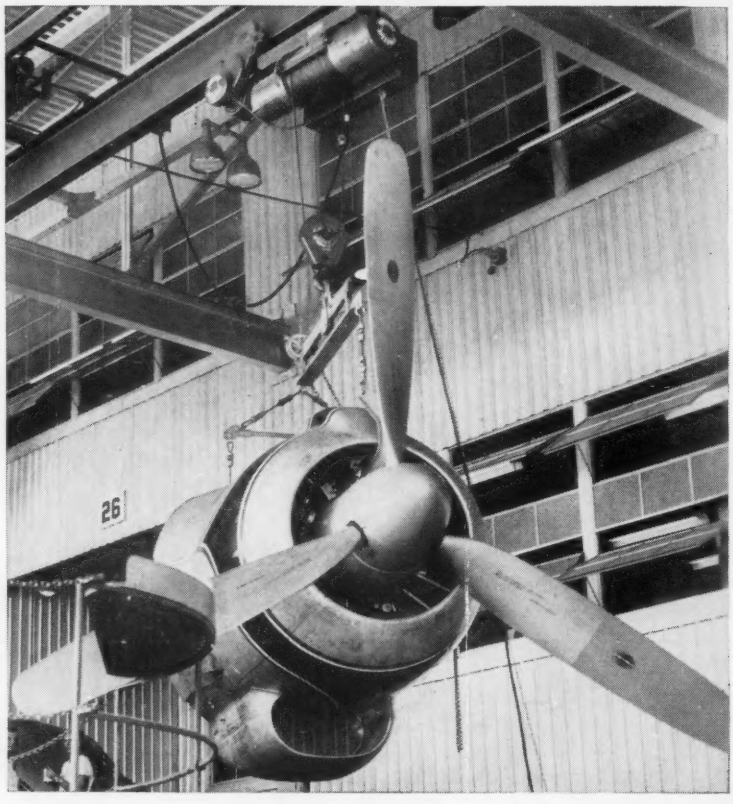

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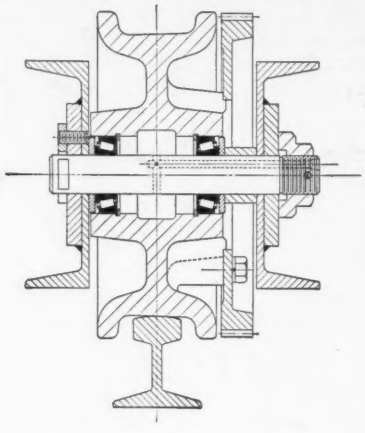

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